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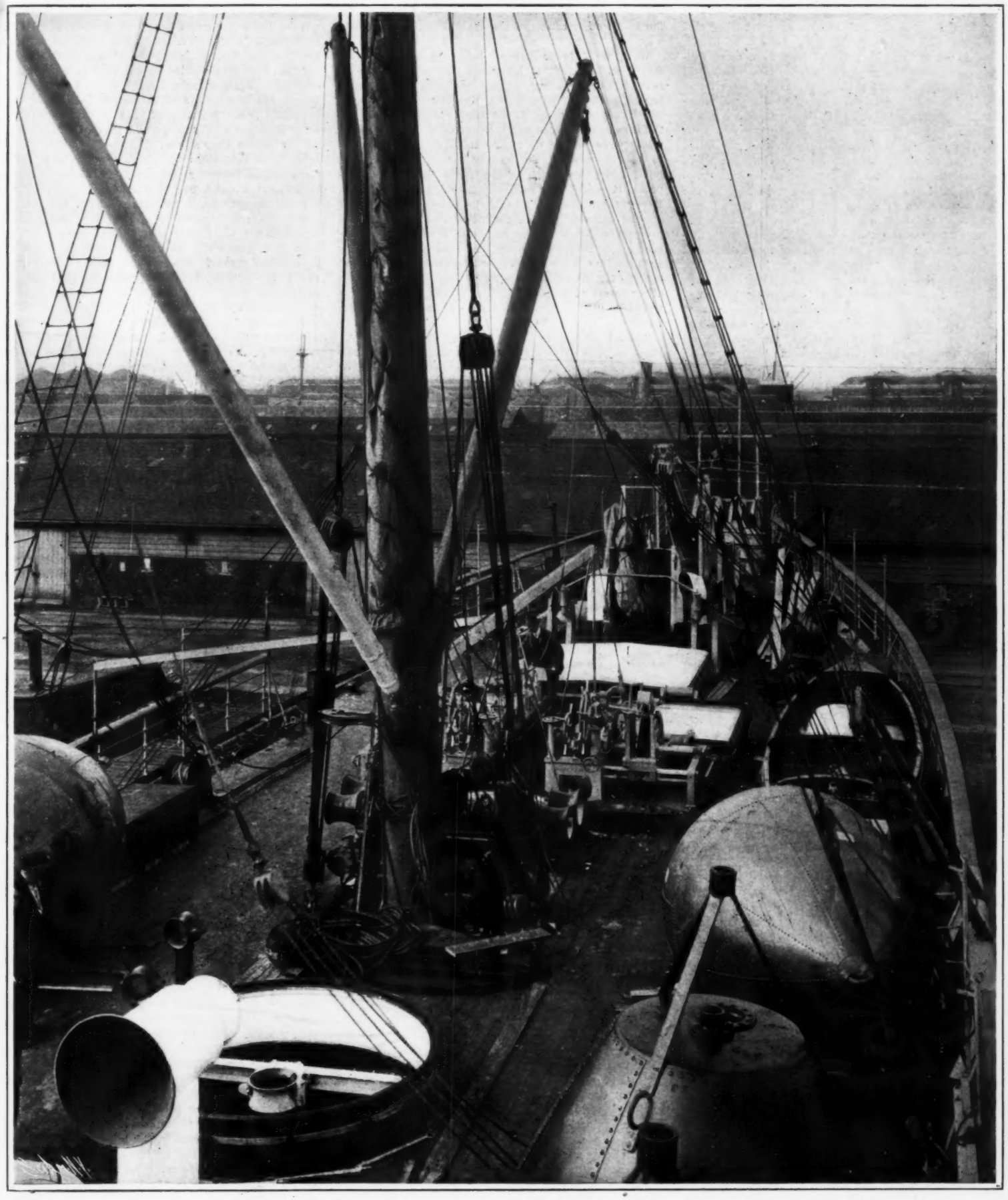


THE SPAR DECK, WHERE THE CABLE-LAYING MACHINERY IS PLACED.

A NEW CABLE SHIP.—[See page 377.]

PROBLEMS OF APPLIED CHEMISTRY.*

SOME PRACTICAL CONSIDERATIONS.

BY PROF. GEORGE LUNGE.

WE are, in these days, so much accustomed to deal with electricity in its innumerable applications, that we are apt to forget how recent is the introduction of that force of nature into practical chemistry. One of the finest heads among English alkali makers, whose grasp of the principles of science far surpassed that of most ordinary technical chemists, Dr. Ferdinand Hurter, pronounced himself, as late as 1888, decidedly against the commercial possibility of introducing electricity, as an agent for manufacturing the cheaper class of chemicals. But within a very few years of that date the contrary had become an established and well-known fact, even in his own domain of alkali. True, in hardly any field have there been more failures to translate the results of science into economical manufacturing processes than in that of electricity; and even now it is only quite exceptionally that, wherever the electric current has to be produced by means of steam, electro-chemical methods can compete with the older ones for the manufacture of what are called "heavy chemicals." This is easily understood when we remember that about 90 per cent of the heat value of coal, or its equivalent of energy, is lost in the circuitous routes of steam boiler, steam engine, and dynamo. But there are several ways in which the problem of obtaining cheaper electricity is being grappled with; and, if most of these have to be dismissed for the present, as belonging to the "music of the future," we have at least one which is a hard fact, and that is the generation of electricity by water power. Unfortunately, in the British Isles the amount of available water power is very limited in comparison with that in many other countries. It is a curious coincidence that those two European countries which are the greatest producers of coal, Great Britain and Germany, should be less favored by nature in respect of water power than other countries which possess little or no mineral fuel, as do Sweden, Norway, Switzerland, France, Italy, and Spain. A very different condition of affairs obtains in the United States, where we find the greatest coal fields combined with the greatest amount of water power existing in any civilized country. It is impossible to shut one's eyes to the fact that the day will inevitably come when the coal fields will be so far exhausted that all those industries which consume large amounts of mechanical energy will be forced to emigrate to countries where water power is abundant.

No other substitute has, as yet, been found for generating force, and, indirectly, electricity. True, the energy given out by the descent of water in rivers is but a small fraction of that which is radiated upon the earth from the sun, or of that which is developed by the play of the tides and the force of the wind, but no way has yet been found of utilizing these other sources of energy, except to the slenderest extent. The harnessing of these natural agents belongs, so far as we can see, to the class of problems which will hardly be solved by our own generation, whatever developments the remoter future may bring. But of the water power existing on this planet there is a large proportion which has never yet been touched, and this, as well as the water power which has been already forced into the bonds of man, runs on forever. This is, of course, an incalculable advantage over coal, which, by its use as fuel, is dissipated into the atmosphere in the shape of carbon dioxide, and thus altogether destroyed as a source of energy, since from carbon dioxide fresh fuel can only be generated by the intervention of solar energy, and this takes place at such a very slow rate that it cannot be taken into account in our economical considerations.

We, who have been born to see the ascendency of coal as the principal producer of energy in bulk, can hardly realize what a short epoch in the past and future history of mankind belongs to the age of coal. It has taken many thousands of years to form the beds of coal which exist in the earth's crust, and which have preserved to us a tiny portion of the solar energy radiated upon our planet during that period, millions of years ago. At that period, for various reasons, the production of living matter must have been incomparably more rapid than is the case at present. During untold ages this stored up energy was lying idle, hidden under the accumulations of the more recent geological formations, not merely up to the advent of man, but through nearly the whole of his history. Leaving aside the tens of thousands or (according to some) hundreds of thousands of years during which man existed before the dawn of history, we must remember that historical documents exist in Egypt, Babylon, India, and elsewhere, taking us back at least 8,000 years, and that the most glorious times of Greek and Roman civilization are about 2,000 years behind us. How modern, in view of these figures, is the use of the coal, and over what a short time will it extend! In these isles, the use of coal is much older than in any other country, but even here its serious exploitation is comparatively recent, dating barely 150 years back; while its future (even if we disregard the more pessimistic estimates) is not likely to exceed some 200, or at most 300, years. Germany and the United States will probably hold out 200 or 300 years longer, but in all other countries the chances are all the other way.

Well, what is to happen then? Those countries where water power is abundant may possibly substitute electrical heating for that produced by the burning of coal, but what about England and Germany, which are so poorly off in that respect? Even in those countries which are more favored the amount of water power is by no means infinite; and, if it had to be drawn upon, not merely for motive purposes, but for the production of electricity for heating purposes, it would be found insufficient in most places. Here we are faced by one of the greatest problems of applied science, both in chemistry and in physics, a problem which will give plenty of occupation to generations of future inventors. At present we can only surmise that some solution will present itself in the shape of a direct conversion of the sun's rays into other forms of energy; but the means by which this would be practically accomplished are at present quite uncertain.

The age of coal, in the midst of which we are living, short as it is evidently doomed to be in the long history of mankind, has been of incalculable service. For our purposes we may dismiss the earlier part of it, and look back only a hundred years. In all branches of industry, in locomotion, in the means of communication, and in innumerable matters ministering to the comforts of life, the progress since that time has been going on at a geometrical ratio. The present state of all these factors of civilization in Europe (to say nothing of America) differs from that obtaining a hundred years ago far more than the latter differed from the Roman Era, or even from the age of the Egyptian kings. And this miracle has been brought about solely by coal, without the aid of which it is simply impossible to imagine the revolution which has taken place since then. "Railways!" That single word, to give only one instance, will bring this home to anyone who ponders over this matter. And it is equally impossible for us to imagine that, during the past century, there could have been any other invention, based upon the utilization of the other supplies of energy of which we have spoken, which could have replaced the untold services of coal, that accumulator of solar energy, which alone has enabled the human mind to work out the thousand and one channels through which modern civilized life is flowing. We may say this with all confidence, for how otherwise could we account for the fact that such inventions have not been made in former times, when there were certainly quite as many ingenious minds in the world as during the coal-consuming age?

Let us now come down to considerations of a more modest, but more practical nature than those in which we have just been indulging. Seeing that the stock of mineral fuel upon this earth is so very limited, cannot we find means of husbanding it more than this has been done hitherto? It is only too notorious that the way in which coal is at present consumed is most wasteful. Of the energy residing in coal, most ordinary steam engines utilize less than 10 per cent by converting it into mechanical motion; and even the most perfect steam engines devised utilize hardly more than 15 per cent. Improvements in this direction may possibly swell this proportion a little, but there is no prospect of gaining much in that direction. Enormous wastages are also incurred in other ways. The conversion of pig iron into steel, the manufacture of glass and many other industries consume from four to twenty times, and even more, of the quantity of coal required by theory. Many descriptions of coal are too poor to be used at all, except in the immediate vicinity of the spot where they occur; and in burning our fuel, whether it be for industrial or for technical purposes, we invariably send its nitrogen into the atmosphere, which surely contains quite enough of that commodity; the only exception being the manufacture of coal gas, to which we shall refer later on. Here some of the grandest problems of applied chemistry present themselves to us—how to stop that fearful waste of fuel; and how to recover the nitrogen of the coal, if that be possible.

It is certain that we must look for the solution of these questions in the direction of converting coal into gaseous fuel. It is true that much has been done in that field in past years, and more especially will the name "Siemens" occur to every one in this connection, but much more remains to be accomplished. Another great stride ahead lies in the better utilization of the waste gases from blast furnaces, in which respect the last few years have witnessed some very important improvements. All this refers merely to a better utilization of the heating power of coal, but not to that other great task, the recovery of nitrogen in a useful shape. This, together with the question how coal of poor quality is to be turned to a better account, has been tackled by the equally indefatigable and intelligently directed energy of Dr. Ludwig Mond, one of the benefactors of the Royal Institution. His invention, the "power gas," has already attained a large measure of success, as is proved by the extent of the plants erected and designed. Mond's process belongs to that class by which we approach one of the greatest problems, for the time being, of applied chemistry; I mean the conversion of nitrogen from sources not yet opened out into ammonia and nitrates.

The immense importance of this latter problem lies in the fact that it touches our most urgent want, our supply of food. The soil of most countries, if tilled in the old manner, would not nearly suffice for the production of the requisite amount of food for men and cattle, while the limits of its producing capacity are being gradually narrowed down by exhaustion. The importation of foodstuffs from other less thickly populated countries can only modify, but not altogether extinguish, the danger of ultimate shortness of food at some future date, possibly not so very remote. It is certainly a great comfort to know that, with suitable manuring, the soil may be forced to yield even better crops than it would give in the virgin state, let alone in a condition impoverished by centuries of tilling. But stable manure is nothing like sufficient to attain that object, and we must turn to mineral fertilizers, principally phosphates, potassium salts, and nitrogen compounds. The two former classes of fertilizers are found in abundance in nature, and there is no danger apparently of their being exhausted during the next thousand years.

But the case is very different with the mineral forms of nitrogenous manures, i. e., ammonium salts and nitrates. For agricultural purposes it does not make much difference whether we apply the nitrogen in one or the other of these forms. The ammonia, apart from insignificant quantities otherwise obtained, all comes from the nitrogen of the coal, but up to about twenty years ago only that coal which was used in the manufacture of gas was made to yield ammonia, and only one-sixth of its nitrogen was obtained in this form. In all other uses of coal, where at least twenty times as much is consumed as in the manufacture of gas, the nitrogen was simply sent into the air.

Quite recently some progress has been made in the way of utilizing some of this nitrogen as well. I have already mentioned the Mond process, where some of the nitrogen is recovered in the shape of ammonia; but this covers only one corner of the field. In another section a good deal has been already achieved. In the manufacture of coke, which is also a process of destructive distillation, and entirely analogous to gas making, very much larger quantities of coal are consumed than for the latter, since coke is indispensable for the smelting of iron and for other metallurgical purposes. Up to about twenty years ago all the volatile by-products in the manufacture of coke were lost—that is to say, tar, gas, and ammonia. The recovery of these by-products was first carried through in one of two French coke works, about 1861, but nowhere else for a number of years, although in 1879 the late Dr. R. Angus Smith had earnestly recommended to the English coke works the adoption of that system. Even now, both in France and England as well as in America, the recovery coke ovens have found only a very limited adoption; in England perhaps 5 per cent of the coke is made in this way, against upward of 50 per cent in Germany. In consequence of this, while twenty years ago Germany imported nearly all of the ammonium sulphate required for its agriculture from this country, she now imports none, and has, on the contrary, become a large exporter of that commodity. The reasons for this wonderful change are various. One of them is undoubtedly the revival of that spirit of push and enterprise which, after lying dormant for centuries in consequence of the ravages of the Thirty Years' War, caught up the German people, and enlivened German industry

* Part of an address delivered at the Royal Institution, London.

in all directions. Without going into details on this matter, we may take it that a considerable reserve of ammoniacal nitrogen exists in the quarter indicated, and that the present production of about half a million tons of ammonium sulphate might be greatly increased in that manner.

But that reserve is, after all, nothing like sufficient to cover the requirements of agriculture in the future; and it is quite likely that in the long run all the really available nitrogen of the coal would not suffice for the wants of man. And what about the time when coal itself will be exhausted? Well, there is an eternal and inexhaustible source of nitrogen to which we must turn, and that is the atmospheric air. Four-fifths of this consists of nitrogen, calculated to amount to 4,000 billions of tons, mixed with a quarter of that weight of oxygen. More than 100 years ago, in 1785, Cavendish discovered the fundamental fact that, by the action of the electric arc, the nitrogen of the air combines with oxygen to form nitric acid. The formation of ammonia from atmospheric nitrogen has also been effected, both by electricity and (which is more important) in other ways as well, as we shall see anon. But until a very few years ago these facts have never been put to any practical use, and the problem of turning the atmospheric nitrogen into ammonia, or nitric acid, although frequently approached in a purely scientific or, experimentally, in a technical way, had not been solved. Our days have seen the realization of that most important task.

Let us first speak of ammonia. We are led up to this by what is, verily, a long and circuitous path. We must start from the discovery of calcium carbide (announced in 1862 by the celebrated Woehler), the technical preparation of which substance was first effected by Wilson in 1892, and about the same time by Moissan. True, the expectations that were entertained in various quarters in connection with this remarkable chemical product have not been fully realized to the extent anticipated by the inventors; but, on the other hand, an entirely novel use has been discovered for it by Prof. Adolf Frank and Dr. Caro, of Berlin. They found that when nitrogen is passed over red-hot calcium carbide it is absorbed with formation of calcium cyanide. This latter, when treated with water under high pressure, is made to yield ammonia; but it is not necessary to do this, since the crude product, which they have called "lime-nitrogen," can serve directly as nitrogenous fertilizer, and is in that respect equivalent to its own weight of ammonium sulphate. This is, indeed, its principal use for the present and the near future; but, as a matter of fact, the discoverers go much further. From the lime-nitrogen they prepare cyanogen derivatives of various kinds, some of which are valuable as constituents of explosives, and they are earnestly trying to employ it in the manufacture of nitric acid. They have also brought in several other industries—the manufacture of pure graphite, of pure hydrogen, of urea, and so forth. The pure nitrogen required for all this was at first produced by passing atmospheric air over red-hot copper; but it is now made by liquefying air and distilling off the oxygen, which is thus obtained as a valuable by-product. The inventors expressly recognize the invaluable aid which they have in this respect derived from the world-renowned researches of Sir James Dewar, carried out in the Royal Institution. The works already in operation, or in course of construction, will by the end of this year utilize water-power to the extent of some 55,000 H. P., and will produce lime-nitrogen equivalent to 100,000 tons of nitrate of soda, and this with an expenditure of force less than one-third of that required for the process of Birkeland and Eyde, of which I shall speak directly.

I must, however, first say a word about the strenuous efforts made by Prof. Frank and Dr. Caro, this time in connection with Dr. Ludwig Mond, to extract from peat both power and ammonia. Enormous, but hitherto almost worthless, deposits of peat exist in Ireland and North Germany; and the ultimate success of these endeavors, which we have every reason to hope for, will prove an incalculable boon to these countries. At the same time, all fears of a scarcity of ammonia for agricultural purposes would be thus removed for generations to come.

Important as ammonia is as a fertilizer, it ranks after the nitrates in that respect; and, unlike ammonia, the nitrogen of the nitrates is of immense importance for other purposes as well, viz., the manufacture of nitric acid and of explosives. The very limited quantities of nitrates required in former times, amounting to a few tens of thousands of tons per annum, were furnisned by Indian salt-peter, that is, crude potassium nitrate. A far more abundant supply was opened out a little more than half a century ago, when the exploitation of the beds of nitrate of soda in South America was begun. The crude nitrate found there is refined on the spot, and comes to us as "Chilian salt-peter," which is almost pure sodium nitrate, to the tune of a million and a half tons per annum. About four-fifths of this is taken up by agriculture, the remainder serving, in the first place, for the preparation of nitric acid. As for that acid, it is impossible to imagine how we could do without it. Apart from minor, but quite indispensable uses, one of which is in the manufacture of sulphuric acid by the lead-chamber process, the greater part of nitric acid is consumed in the manufacture of coal-tar colors and in that of explosives.

Let us pause for a minute to consider the last-named. Even supposing it possible that all wars could be abolished on this terrestrial globe—contingency not very likely to arise within the next few years, in spite of the laudable efforts of the Peace Societies—and that gunpowder were no longer required for shooting wild animals (an equally unlikely case, which would lead to a quite intolerable increase of game, big and otherwise) we cannot conceive the possibility of our present system of civilization enduring without a colossal consumption of explosives. How could we carry on mining operations without them? How could we get stones from the quarries? How could we construct roads, and tunnels, and railways without the help of explosives, all of which have a basis of salts or esters of nitric acid? And these have, up to the present, been prepared almost exclusively from Chilian saltpeter. The idea has certainly been mooted to imitate the natural process by which the nitrate is formed in India. This has been tried during a number of years in France and in Sweden, but has been given up as unprofitable in our northern climes. Also, the interesting experiment of sowing the bacillus of nitrification and of cultivating it in the soil has proved a failure, although I would fain believe that the last word has not been spoken on that subject. This, if successful, would replace some of the nitrates now used as fertilizer, just as a better utilization of sewage would act in the same direction; but all this at the best goes only a very small way, and does not furnish the pure saltpeter required for the manufacture of nitric acid. What, then, shall we do when the niter beds of Chili are exhausted?—an event which, according to most estimates, is bound to take place within thirty or forty years from now. Unfortunately, there is no tangible hope of similar beds being found in any other localities, certainly not to any great extent. The beds of Atacama and Tarapaca on the Cordillera owe their origin to an altogether exceptional combination of climatic conditions and geological changes, the repetition of which in other quarters is exceedingly unlikely. Until very few years ago there was no prospect of any fresh supplies of nitrates in any other direction; but we may say that the solution of this problem, if not altogether settled in its final shape, has now been found. After many unsuccessful attempts at realizing for practical purposes the discovery of Cavendish, and after a thorough investigation of its scientific principles by Lord Rayleigh, Muthmann and Hofer, Nernst, Haber, and others, this has been achieved, and once more, by means of that well-nigh omnipotent agent, electricity, which thus renders yet another service to mankind. At Notodden, in the Norwegian Hitterdal, a factory has been established to carry out the process of Birkeland and Eyde, who, by an ingenious application of the extreme heat produced by the electric current, make the nitrogen and oxygen of air combine to nitric oxide, which at a lower temperature is spontaneously decomposed into nitrous vapors, with the ultimate production of nitrites or nitrates. This time there is really no doubt that a practical and economical process has been discovered for which it is intended to employ, by the end of this year, water power to the extent of 30,000 horse-power. The Notodden process bids fair to be followed by other even more efficient processes. The most important of these is that of the Badische Anilin und Soda-Fabrik, for which an experimental factory is in course of construction, and for which 50,000 H. P. are to be employed. But for some time to come the Chilian salt-peter will still rule the trade; a very large amount of water power will, indeed, have to be brought into use merely to cover the annual increment of consumption of this commodity for agricultural purposes.

One task it is certain that explosives will never fulfill, and that was suggested to me by one of the cleverest mechanical engineers I have known. He was intensely interested in the problem of aerial navigation, and for this purpose he wished to construct an engine worked by fuel of the most concentrated kind. Neither coal nor benzine nor oil would do. In his plight he came to me and asked what explosives I should advise him to try for working his engine, in the erroneous idea that explosives were a kind of concentrated fuel. Of course, I could not but reply as follows: All honor to his courage, but no explosive known, so far ever or likely to be invented, could possess that property he required, viz., a large store of energy. A pound of coal represents five times as much energy as a pound of the strongest explosive known—blasting gelatine. My friend had overlooked the fact that a pound of dynamite, though it gives out nearly 150,000,000 H. P., does so only for the space of 1/50,000 of a second. He had omitted to take into account the element of time and had confused power in the ordinary sense with energy, which is the capacity for doing work.

A similar confusion is sometimes made between energy and the creation of high temperatures. This can be very well illustrated by the use recently made of finely-powdered aluminium, both as a component of explosives and as an agent for producing very high temperatures, in the shape of Dr. Goldschmidt's "thermite." In both cases the fact is utilized that aluminium is easily, and in the shape of fine powder, almost instantaneously, converted into its oxide, alumina, by substances capable of giving off oxygen. In the case of thermite, a mixture of finely-powdered aluminium and ferric oxide is, when lighted, decomposed instantaneously into molten iron and aluminium oxide. The heat produced thereby far exceeds that produced by coal in any conceivable way; it is equal to that of the electric arc. One of the most important applications of this agent occurs in the welding of the ends of railway rails, when already laid down, into one continuous rail of any length required. And yet the total energy of thermite is only 450 thermal units per kilogramme, or in other words, about one-twentieth of that of the best coal. But, whereas it takes a good deal of time to burn a pound of coal, during which process there is a great loss of heat by radiation, and the heat is spread over a current of gases which we call the flame, a pound of thermite burns off in about one second, and, as there are no gaseous products formed, all the heat generated remains within the molten iron and alumina, which accounts for the extreme degree of heat to which these are brought.

Electricity has often been invoked to produce the most important of all inorganic products, iron. If this problem could ever be solved in an economical way, it would bring about a perfect revolution in the position of the leading nations. On the one hand, the enormous quantity of coal now consumed in the production of iron and steel (which is probably at least a quarter of the entire output of coal) would be set free for other uses, and the exhaustion of the coal-fields would be put off to a corresponding extent. On the other hand, the production of iron would pass over into the hands of those nations which command the largest amount of water-power, and which, therefore, can produce electricity most cheaply. Of the three countries which now produce between them the bulk, that is seven-eighths, of the world's iron, Great Britain and Germany would go to the wall, and the United States, which already produces more iron than these two countries put together, would become omnipotent in that field. Sweden, Italy, and some other countries would, at any rate, greatly increase their present production. But this radical change is, as yet, far off. No proof has, so far, been given that pig-iron, or the ordinary descriptions of wrought-iron and steel, can be generally produced by electricity at anything like the price at which it is now done by coal in the great industrial centers. Where a certain success has been scored in the electrical metallurgy of iron, it is for the refining of ordinary iron into a superior grade of steel which fetches an extraordinary high price, and in the production of certain alloys of iron with chromium, nickel, and the like, whereby so-called special steels are obtained. But if at the present moment we do not see our blast furnaces and Bessemer works threatened by the competition of electrical iron, who can tell how soon this may not be the case?

The limits of my time have been too nearly reached for me to discourse upon many other problems which present themselves in inorganic applied chemistry, and only a few minutes are left to speak of those belonging to the domain of organic chemistry.

I will point to only two problems of this kind. One of these is the substitution of artificial for natural coloring matters. This, indeed, has now been carried out almost to the bitter end. Long ago, one of the oldest and most widely-used coloring matters, that contained in madder, succumbed to the attacks of the chemists, among whom the names of Edward Schunck and William Henry Perkin testify to the glorious share taken by Englishmen in that victory. The coloring substance of madder—alizarine—is now made from English coal-tar, and has altogether taken the place of the impure form in which it occurs in the madder plant. The growers of this plant in the south of France and elsewhere have had to abandon its culture altogether, to their great sorrow.

A similar fate has already partly overtaken, and may, in the end, destroy entirely, the culture of indigo, most of which, as you know, comes from British India, and formerly represented a value of some four million pounds sterling per annum. At first, after the great Munich chemist, Adolf Baeyer, had prepared the coloring matter of indigo by synthesis in his laboratory, the planters merely shrugged their shoulders, and that with good reason, since Baeyer's processes could not compete with their produce in respect to cost price. Another circumstance which at that time militated against artificial indigo was this, that it started from toluene, the total available quantity of which substance would not have sufficed

for producing anything like all the indigo required, even if no toluene were used for other purposes, which is out of the question. But this state of matters has changed.

Some twelve years ago the late Carl Heumann, assistant professor in my laboratory at Zurich, discovered the synthesis of indigotine from naphthalene. This, like toluene, we get from coal-tar, but in about ten times the quantity, so that there is no fear of any scarcity of naphthalene even in the future. The late Dr. Rudolph Knietsch at the Badische Anilin und Sodafabrik at Ludwigshafen gradually transformed Heumann's laboratory process into a factory process, which is working with entire success on a large scale. Synthetic indigotine is now manufactured at such a low price that its competition has proved a severe blow to the indigo-planting interests. Thus the triumph of scientific investigation and practical skill in chemical manufacturing, gratifying though it be as a splendid achievement of applied chemistry, is a sad trial to many thousands of Indian ryots and their British masters; and this is merely the foretaste of what will inevitably happen in many other cases. What is food for one is poison for another.

Most other vegetable coloring matters, several of which have also been synthetically produced, have become useless by the discovery of hundreds, and even thousands, of artificial coloring matters far exceeding them in beauty, and often also in fastness. On this well-known point I cannot dwell now.

In conclusion, I would touch upon what is, perhaps, the very greatest problem of applied chemistry, and that is the direct production of feeding-stuffs for man and beast. The synthesis of alimentary substances from inorganic matter has, up to this moment, not been even remotely achieved, nor can we at present so much as guess the direction in which this might be done; while, as for the production of food from sawdust and other waste organic substances, we are in no better case. But even here the word "impossible" should not be pronounced. In a more modest form, at all events, chemistry has found magnificent scope in that quarter—I mean in the extraction of alimentary substances from new sources and in the increase of production from old ones. The colossal industry of beet-root sugar is an instance of the former, while agricultural chemistry, as a whole, works in the latter direction.—Technical Literature.

THE SENLECQ TELECTROSCOPE.

AN APPARATUS FOR ELECTRICAL VISION.

A RECENT French patent (No. 375,745) was granted to Constantin Senlecq for an apparatus for electrical vision at a distance, a problem on which the inventor has been working for thirty years. He calls his apparatus a telectroscope.

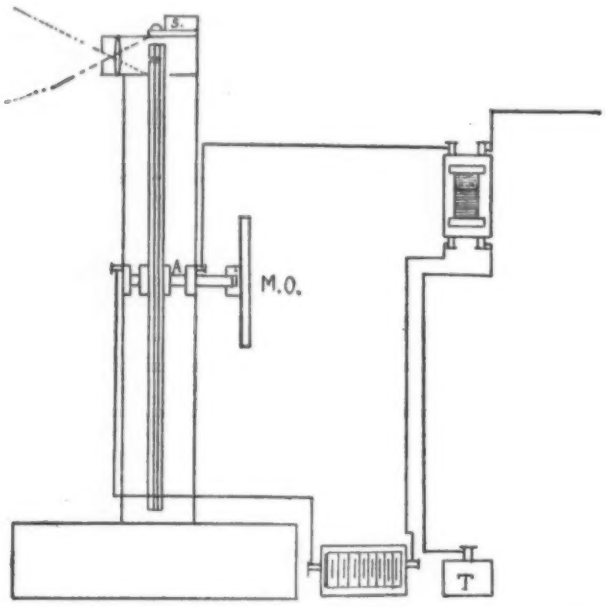


FIG. 1.—TELECTROSCOPE TRANSMITTER.

A reduced image of the scene or object is thrown by a short focus lens upon the peripheral part of a rapidly rotating disk (Figs. 1, 2, and 3), which consists of two sheets of copper separated by a sheet of mica. The mica and the sheet of copper which faces the lens are perforated with a number of small holes, arranged spirally in such a manner that one, and only one, hole is always opposite some part of the projected image (*A*, Fig. 3), and that every part of the image is visited by one or another hole in the course of a revolution of the composite disk.

These holes are filled with selenium, which establishes electrical communication between the two copper disks, which are connected with a battery and line wire (or the primary of an induction coil) as shown in Fig. 1.*

* Senlecq's patent specification, from which this description is derived, makes no mention of an induction coil, though the coil is shown in his accompanying drawing, of which Fig. 1 is a reproduction.

The resistance of the circuit and, consequently, the strength of the current are determined mainly by the illumination of the selenium plug which is passing the image, as the other plugs are in darkness and hence have very high resistance. The current strength, therefore, varies in a manner which depends on the luminous intensities of the parts of the projected image which successively fall on the moving selenium plug that is within the limits of the image.

At the receiving station, a single metal disk (Figs. 4 and 5), perforated in the manner above described, is caused to rotate synchronously with the transmitter disk, and the upper part of its peripheral zone is illuminated by the rays of a powerful lamp *C*, reflected by a concave mirror *H*. The varying current from the transmitting station, on arriving at the receiving station, passes through the solenoidal galvanometer *A*, the plunger of which moves, by means of a multiplying lever, a small graduated screen up and down before the passing hole on the rotating disk. This screen *V* is only 1/25 inch in height yet it comprises every gradation of tone from perfect transparency to perfect opacity. It is made by photographing on a reduced scale, on a very thin plate or film, a larger

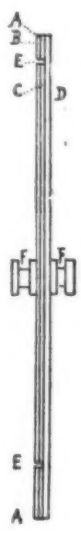


FIG. 2.—TRIPLE DISK OF TRANSMITTER.

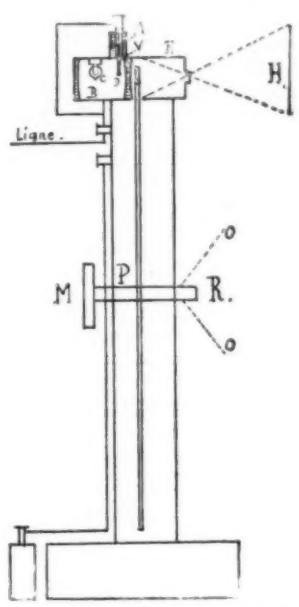


FIG. 5.—TELECTROSCOPE RECEIVER.

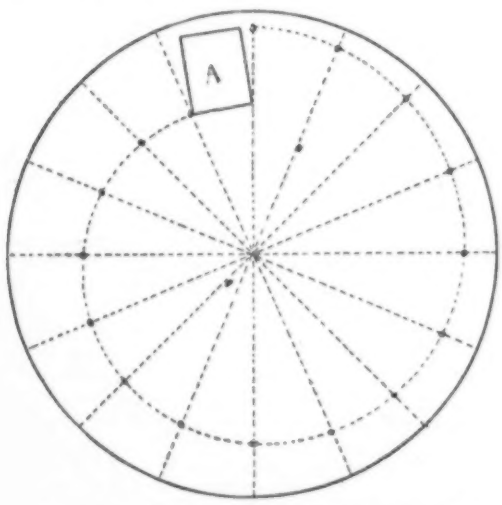


FIG. 3.—TRIPLE DISK OF TRANSMITTER.

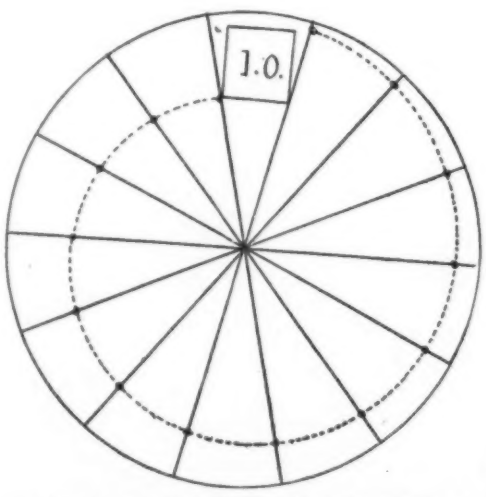


FIG. 4.—SINGLE DISK OF RECEIVER.

the receiving disk will perceive a point of brightness proportional to that of the corresponding point of the original scene or object and, because of the persistence of impressions on the retina, the successive points thus determined will combine to form a visual image of that scene or object, with the proper distribution of light and shade, though not, of course, of color. By the use of projecting lenses the image may be thrown on a screen to form an enlarged picture, moving or still according to the character of the original scene.

The transmitting and receiving disks may be 16 or 20 inches in diameter, or even larger, but they must revolve at least 10 times per second and with perfect synchronism. This synchronism may be attained by the Hughes or other well known methods. The slightest irregularity, furthermore, is betrayed by indistinctness in the received image, and a screw is provided by which the speed of the receiving disk can be altered until exact isochronism is obtained and the picture becomes distinct. For the sake of lightness, but chiefly in order to diminish the length and, consequently, the resistance of the selenium plugs, the copper and mica disks of the transmitter are made as thin as a sheet of paper.

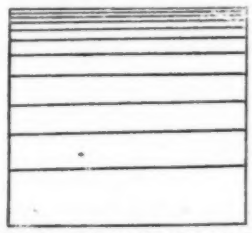


FIG. 6.—SHADED SURFACE USED IN MAKING SCREEN.

A great deal depends upon the preparation of the selenium plugs, for the selenium must be in the crystalline state, in which it is most sensitive to light. The following method is used: The triple disk having been strongly heated, the holes are filled with selen-

ium by rubbing the surface with a rod of that substance. The disk is then heated to the melting point of selenium (217 deg. C. or 423 deg. F.), allowed to cool and polished to remove any roughness that may have been produced in the selenizing process. The triple disk is then placed in an oven, which is heated gradually to the melting point of selenium, the fire is drawn and the disk is allowed to cool very slowly, in the oven, to atmospheric temperature. The slowness of cooling is of prime importance.

The transmitting and receiving disks are driven, preferably, by electric motors.

SOME SOLDERING APPLIANCES.*

THE BLOWPIPE AND THE FURNACE.

VARIOUS tools are used in soldering to produce a local flame so hot as to melt the solder; and the necessity of keeping the flame at the proper temperature has brought about various modifications of them.

Many solders melt only at very high temperatures, as, for example, those which contain gold or platinum, and require the greatest possible heat; this is advisable, indeed, in other cases, since the soldering can be done more quickly, and without danger of accidents, such as the partial melting only of the solder.

FIG. 1. FIG. 2.

SOLDERING PIPES.

The heat of any flame, whether candle, oil, alcohol, or gas, is increased by forcing air into it. The burning is the result of the combination of the combustible material contained in the substance with the oxygen of the air, and if enough oxygen or air is introduced into the flame to bring about perfect and rapid combustion, a very high temperature will be produced.

Upon these facts are based all the soldering apparatus which are arranged to force a strong current of air into the flame. To this class belong the soldering pipes of various forms, bellows and blowpipes. In the so-called soldering lamps, a small stream of the fumes from some burning fluid, alcohol, turpentine, oil, or benzine, is forced out from a small opening in a tube. If this is lighted as it issues, a very hot flame is produced, which can be directed upon the solder to be melted.

For many purposes, the ordinary blowpipes are not sufficient, and the heat of the flame must be increased, either by introducing oxygen, or by using a fuel which engenders an unusual amount of heat in combustion. Ordinary illuminating gas is such a fuel; by the introduction of compressed air, a heat is produced which will melt any solder; and by forcing in pure oxygen, it is possible to melt even platinum, one of the least fusible of all metals. Hydrogen gas develops great heat in combustion; mixed with air or oxygen, it produces the oxyhydrogen flame, which has the highest attainable temperature, with the exception of that which is evolved between the carbon points of an electric arc lamp. At the present time, the art of soldering by the aid of electricity is in active development. The oxyhydrogen flame is of the greatest value in many cases. It is employed in soldering lead plates for chemical purposes, and for joining pieces of platinum without solder.

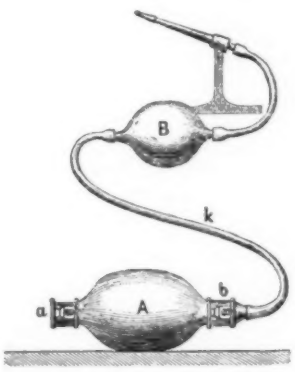


FIG. 3.—SOLDERING BLOWPIPE WITH BELLOWS.

The Soldering Pipe.—This familiar little instrument can be used where small solderings are to be done. It gives a strong heat, and small quantities of very hard solders can be easily melted by means of it. Some metal workers, especially workers in gold, use no other apparatus. In its simplest form, as illustrated in Fig. 1, it consists of a conical brass tube, bent at a right angle, and ending in a fine point, through which a current of air can be forced with considerable power. With continued blowing, more or less moisture will unavoidably gather in the tube, and spatter out at the opening in such a way as to disturb the work; it is well to have a wind-box where the moisture is retained (Fig. 2) and from which it can be removed from time to time; also to have a platinum point *P*.

In working with the ordinary soldering pipe, only one hand is free, as the other is occupied with holding the pipe. Since India rubber has come into general use, this disadvantage has been overcome by fastening the tube to a holder of suitable form, with a rubber pipe and mouthpiece. As constant blowing is also wearisome, a blowpipe with bellows has been devised to spare the lungs of the workman. This consists of an egg-shaped bag, *A*, of vulcanized rubber (Fig. 3) with two valves, *a* and *b*. The valve *a* opens inward, the valve *b* outward. A rubber tube, *k*, leads from this vessel, which rests upon the floor, to the work table, where it is connected with a second bag of the same shape, from which a rubber tube leads to the soldering pipe. By pressing with the foot upon the bag *A*, the air is compressed, opens the valve *b* and enters the bag *B* by the tube *k*. When the pressure ceases, *A* immediately expands again by the force of its elasticity, and the valve *a* is opened by the exterior air pressure, to be closed again, and *b* opened, and so on. The bag *B* is strongly expanded by the air forced into it, and serves as a reservoir.

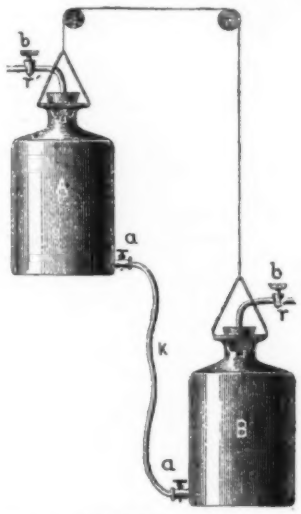


FIG. 4.—BOTTLE BLOWPIPE.

The Bottle Blowpipe.—For the construction of this very convenient apparatus, two large glass or sheet metal bottles are needed, of at least three gallons capacity, and constructed with necks. (Fig. 4.) The bottle *A*, which should stand four to six feet higher than *B*, is filled with water, and the two are connected by the rubber tube *K*. Both bottles are corked, and in the corks are inserted tubes, bent at a right angle, which can be connected with the soldering pipe by a rubber tube. If the cocks *a* and *b* are opened, the water from *A* enters *B* through *K*, and expels the air, which is then forced into the soldering pipe through the tube *r*. When the bottle *B* is nearly filled with water, and *A* correspondingly empty, it is only necessary to change their relative positions, in order to renew the air current. A convenient way of making the change quickly is by means of a strong cord, passing over pulleys, as shown in the drawing. A pull upon the cord will reverse the positions of the bottles, and the work will be interrupted only long enough to do this, and to change the rubber tube from *r* to *r'*. With bottles of the above-mentioned capacity a strong flame can be kept up for fifteen or twenty minutes, and the workman will be enabled to give his whole attention to the soldering in hand, without the labor of blowing.

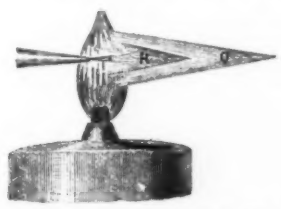


FIG. 5.—SOLDERING PIPE FLAME.

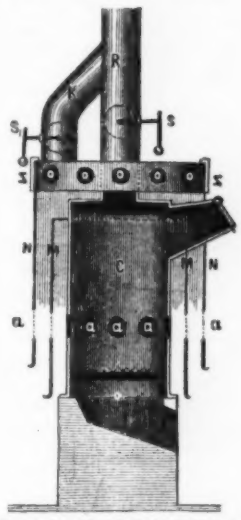


FIG. 6.—SOLDERING FURNACE ACCORDING TO EDMUND SCHLOSSER'S CONSTRUCTION.

In the better kinds of soldering pipes, the point is made of some metal which will not oxidize in heat. Usually a little platinum cap is pushed over the point, or little plates of sheet platinum are used, with tiny openings. (See Fig. 2.)

When the soldering pipe is applied to a flame, this takes a conical shape, according to the force of the blowing. Different parts of the flame exert very different chemical action upon the solder and the metals to be soldered. The flame (Fig. 5) consists of two parts, a cone within a cone, as it were. The smaller inner cone reduces the metallic oxides to metal, and is called the reduction flame. The outer one is called the oxidation flame, and will quickly oxidize an easily fusible metal. If litharge (which is, chemically speaking, oxide of lead, or lead combined with oxygen) is placed upon a coal, and introduced into the reduction flame, a grain of lead will be obtained after a while, the lead oxide having been reduced to lead. If a piece of lead, upon a coal, is treated with the exterior or the oxidation flame, it will be oxidized, or changed into lead oxide. Solders, therefore, containing metals which are easily oxidized, should be melted, indeed, by contact with the point of the oxidation flame, but kept covered with a soldering medium, which at the same time cleanses and excludes the air. Borax, in larger quantities than is necessary for simply cleansing the surfaces, works excellently here.

If enamels, which are glass colored with metallic oxides, are to be melted on a metallic background, it might happen that entirely different shades of color would be produced from those intended. Enamels containing copper and iron require especial care in this respect. Cupric oxide colors the enamel emerald green, but cuprous oxide makes it ruby red. Ferric oxide gives reddish brown, but ferrous oxide bottle green. If then the colors of the simple oxides are to

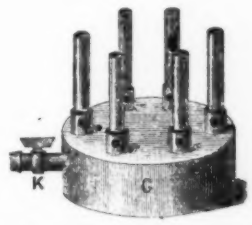


FIG. 7.—APPARATUS FOR HEATING THE SOLDERING TOOL WITH GAS.

* Translated from a chapter in Edmund Schlosser's Das Löten.

be kept pure, the enamels should be melted with the oxidation flame; but the reverse if the protoxide colors are desired; that is, the reduction flame should be employed.

Ordinary tallow candles were formerly used to make the flame; later they were superseded by oil lamps. The use of any kind of fat or oil is attended by inconveniences, and alcohol is now generally used instead of either tallow or kerosene; it also gives a hotter flame. Where the use of illuminating gas is practicable, it is the best material. This is to be lighted as it issues from a pipe of about ⅛ of an inch in inner diameter, and brought into the proper form by the soldering pipe. The flame can be made so hot that a piece of gold as large as a pea will be very soon melted, and platinum wire as heavy as horse hair can be also melted by this flame.

For solderings which require still higher temperatures, but are for small surfaces, the best apparatus is the oxyhydrogen blowpipe, with gas. It is especially suitable for gold and silver work, mathematical and optical instruments, enameling, etc., as it is rapid and cleanly.

The furnaces used by metal workers for heating their soldering tools are, as a rule, very simply but also unsuitably constructed. They are usually merely a square box or cylinder filled with the fuel, and connected with a chimney by a sheet metal pipe. Inside of box or cylinder is a grate, so placed that the space below serves to hold the ashes, and near the bottom are openings through which the soldering tools can be thrust into the red-hot coal or coke.

The disadvantages of this apparatus are great, both as regards the health of the workman and its waste of fuel. In the process of soft soldering, where hydrochloric and other acids are brought into requisition, fumes are evolved which are irritating to the lungs. A furnace of improper construction also gives off coal gas, or carbonic oxide, a gas so poisonous that the presence of a very small quantity in the air of a room produces violent headache.

An apparatus will here be described (invented by Edmund Schlosser) which is free from the above defects, and which possesses special merits. It can be made by any smith from the accompanying diagram. Among other advantages it consumes only so much fuel as is necessary for heating the soldering tool; it prevents the escape of carbonic oxide into the room, and it tends to ventilate the room in summer, while in winter it can be used to heat it.

The construction (Fig. 6) is as follows: The cylinder *C* is made of cast iron, with a clay-cemented cover, into which is inserted a pipe, *R*, connected with the chimney. The cylinder is about two feet high and its diameter about one foot. About six inches above the lower edge of the cylinder is a cast iron grate, and four inches above this are twelve openings, *a*, through which as many soldering tools can be put into the fire. The fuel is put in at a neck on the side, which has an automatically closing door of cast iron. One inch from the cylinder is a sheet metal casing, *M*, and at the same distance again another, *N*. The inner casing is open above and below; the outer one is open at the bottom, but fastened at the top to the pipe, *R*, by a ring-shaped piece of sheet metal, from which goes up a pipe, *K*, opening into the pipe *R* by means of an elbow. The casing *N* has eight circular openings at the top, outside of which is a sheet metal ring, *Z*, with corresponding openings, and movable, so that by means of it the openings, *O*, can be partially or entirely closed. In the pipes *R* and *K* are round, well-fitted valves, *S* and *S'*, with crossbars on the outside. On one end of these bars are metal balls, which hold the valves open, and on the other end little chains by means of which they may be partially or entirely closed.

By the closing of the cylinder *C* at the top, and its connection with the smokepipe, carbonic oxide can never escape into the room; through the grate and the twelve openings for the soldering tools air is constantly sucked in, with the result of ventilating the room. The two casings, *M* and *N*, prevent the radiation of heat, as the air between them and the cylinder is very quickly heated, and rises rapidly. In warm weather, the valve *S'* is left wide open, and the hot air between the cylinder and the casings is carried directly into the chimney. The current of air also makes good ventilation in the room. If it is desired to use the radiated heat for warming the room, the valve *S'* is closed, and the sheet metal ring *Z* is so adjusted that its openings correspond with those of the casing *N*. The heated air will now stream out at these openings, and air entering from below will take its place, and the room will be quickly and evenly heated.

The valve *S* on the pipe *R* serves to regulate the consumption of fuel. The more nearly it is closed, the slower the current of the gases of combustion which rises through the pipe *R*, while at the same time less air enters from below, and it can be placed at the exact point where the necessary heat is produced with the least possible consumption of fuel.

The best fuel is anthracite coke, cut into pieces of the size of large nuts; smaller or larger pieces do not burn so well. If the cylinder is filled at night with the coke, and the valve *S* so adjusted that there is only a slight draft in the cylinder, its whole contents will be found red hot in the morning, and the necessary heat can be obtained in a few minutes by opening the valve wider.

For delicate solderings with small tools, illuminating gas can be very advantageously used for heating. The apparatus is illustrated in the accompanying drawing.

A hollow cylinder about twelve inches in diameter and two inches in height (Fig. 7) is connected with the gas pipe by a rubber tube and fitted with six Bunsen burners.

The soldering tools are placed upon a wire framework arranged around the burners, and will be sufficiently hot in a very short time. With an apparatus of suitable size, large tools can of course be heated; but the consumption of gas in this case would be so great as to make the process too expensive, and furnaces are preferable.

Hard solders are so much more difficult to melt than soft ones, that an entirely different process is required in using them. This kind of solder is not melted by means of the hot soldering tool, and spread upon the surfaces to be soldered, as with soft solder; it is placed upon the spot in the form of grains or filings, together with some soldering medium, and either the surfaces alone or the whole object is heated to a temperature which melts the solder, and both surfaces are fused into one. Formerly the whole object was always heated to the necessary temperature, by means of red-hot coals; but this process is expensive and troublesome, and is now rarely employed; special apparatus are now in use, by which a sufficiently strong heat can be locally produced. These apparatus are of several kinds, from the simple soldering tube to the oxyhydrogen blowpipe, according to the variations in soldering temperatures. We will consider them more fully after describing the older methods of hard soldering.

The work of hard soldering must always begin by fitting the surfaces of the metal together as closely as possible. When they are accurately adjusted, it is advisable to file or sandpaper them once again, in order to make them bright, and they should not be touched afterward with the hands, but must be fastened with wires so that they cannot slip out of place. They are then ready for soldering. The seams are usually moistened with a solution of borax, and the solder applied in the form of grains, mixed with powdered calcined borax. The object is then laid carefully upon the fire, covered, if need be, with red-hot coals, and heated until the solder is melted, and has sunk into the seams, which must be quite full, so that the two surfaces are firmly joined together. In complicated work, where a second soldering is necessary, the first is done with hard solder, and the other with a more fusible one.

The process of soldering differs according as the metals are the same or different; and another thing to be taken into consideration is whether the objects are to be treated mechanically afterward. If they are simply to be filed after soldering, for evenness and smoothness, quite brittle solders can be used, but if there is to be subsequent hammering or stretching, then a solder must be chosen which has the tenacity and ductility to withstand the mechanical manipulation. Solders which contain small quantities of silver are very ductile and tenacious, and in these cases they are to be recommended; the added expense will be amply justified by the ease of the work and its excellence.

In soldering similar metals, especially such as are easily oxidized in heat, like copper and brass, it is desirable to moisten the articles, before heating, with water into which clay has been stirred; the thin coating which will remain upon the metal will protect it from oxidation and can afterward be easily removed by brushing. The surfaces to be soldered must of course not be touched by the mixture.

In hard-soldering similar metals, a solder can be used whose fusing point is only a little below that of the metal itself. The very hardest solders can safely be used for copper, bronze, wrought iron, cast iron, and steel, but in the case of brass, German silver, and other similar alloys the fusibility must be taken into consideration, and the solders employed should not be too hard, lest the articles themselves should melt. In soldering dissimilar metals, such as brass with iron, the solder must be such as suits the more easily fusible metal, and here numerous artifices are practised, which can be learned only by experience. Soldering without solder, or, more correctly speaking, melting together two metal surfaces, has been extensively practised of late. A soldering medium is applied, and the two surfaces are actually fused together. This cannot be done, of course, in an open fire, since the whole of the metal would melt; the places to be soldered are heated by special apparatus; and by using the oxyhydrogen blowpipe this can be done without a soldering medium.

INTERPRETING POWER PLANT TESTS.

WHATEVER may be the object of a test of a commercial power plant, the interpretation of the results secured is unquestionably the most important part of the whole task. Too little emphasis has been laid in the past upon the analysis of test results, in comparison with the pains bestowed upon the test apparatus, its arrangement and readings. To secure consistent figures from a more or less complicated outfit of inter-related machinery during a service trial requires a high order of technical knowledge, but to dissect the detailed columns of test figures obtained in the field and marshal them in groups for or against a given policy in design, construction or operation, calls for the most experienced judgment of the trained engineer.

Without carefully obtained test data it is, of course, almost impossible to draw correct conclusions. No sensible engineer would minimize the need of accurate readings and full records of all unusual conditions arising during a test—and few tests are run off under commercial conditions without the presence of disturbing factors which a pure theorist would overlook in planning the work. To the outsider one day looks very much like another in a plant handling routine service, but the operating man inside the station walls realizes that even in such a uniform business as handling the morning and evening rush hour loads of a street railway system on two successive days in the same season of the year, contingencies and differences in hourly conditions are bound to keep him on the anxious seat until the peak load has been passed. Granting such points as this, however, does not for a moment lessen the responsibility of those who are to interpret the data secured.

The practice in some companies requires the testing engineer to submit comments upon his experiment data when presenting the figures to his executive officers. Such a course does not in any way vitiate the analysis of the figures which higher officer may bring to bear, and in many cases it opens the way toward a much closer co-operation between the head of a department and his subordinates. It is easy for young engineers to fall into the error of assuming that everything needful has been done when a set of test data has been carefully tabulated. If heads of departments would more generally encourage the presentation of critical comments with their subordinates' test figures, even in minor investigations, there is no question that many valuable suggestions would thereby be placed on file, instead of overlooked or lost, as is too often the case. In matters like counting stores and checking up carload shipments figures speak for themselves; but in a power plant test a correct interpretation requires full knowledge of the conditions and arrangements obtaining at the time.

Among the sources of inaccurate deductions from test records are failure to separate different kinds of output in relation to the station load as a whole, omission of instrument, tank and scale calibrations, and consequent calculation of costs without reference to the accuracy of the readings, absence of calorific determinations upon representative fuel samples, neglect of atmospheric and weather conditions in studying the results of chimney and blower performance and failure to appreciate the load factors and efficiencies of individual machines contrasted with the station as a whole. In order to interpret the results of an extensive test on a large plant it is very desirable to know what similar equipment may be expected to do and what it has done in other installations; and if the plant which has been tested is to be modified in arrangement or operating methods, the hours of service of each important unit need to be studied quite as carefully as the possible sources of energy loss in the chain of events between the coal bunker and the bus bar. The condition of the apparatus with regard to repairs and depreciation, its performance at different seasons of the year under varied load conditions, the number of men on the operating shifts and their personal equations all need to be considered before any sweeping change in station design or method of handling is carried into effect. It is a great mistake to make a hasty decision to modify a plant's equipment in the light of a single test taken by itself without relation to daily records of service. If a test shows the existence of unfavorable conditions it is far better to endeavor to improve the economy of the existing installation than to tear out important parts of it on the strength of a single test interpretation. Sweeping changes are better the result of both tests and corroborative operating experience.—Engineering Record.

Welding Powder for Iron to Steel.—35 parts of boracic acid, 30 parts of salt, 27 parts of ferrocyanide of potassium, 7 parts of rosin. For steel to steel: (a) 41 parts of boracic acid, 35 parts of salt, 15 parts ferrocyanide of potassium, 8 parts of calcined soda: (b) 1 part pulverized sulphur, 2 parts salammoniac, 10 parts borax.

PREVENTING FROST ON SHOW WINDOWS.

COLD WEATHER ADVICE.

To prevent frost gathering on show windows numerous schemes have been adopted, but none have been wholly practicable or satisfactory, says a writer in one of our exchanges. They were not adapted to all kinds of buildings or windows, interfered with the view, were difficult to install and maintain, or were not based on a scientific understanding of the problem.

The favorite plans adopted by jewelers are either placing a rapidly revolving electric fan near the glass, or a row of burning gas jets arranged just inside the lower rail of the sash. Either of the above plans is effective but expensive. Some shop keepers try to prevent the frosting by the application of glycerine, alcohol, or other solutions, but these liquids require frequent renewals, are extremely difficult to apply nicely, still harder to thoroughly remove, and are seldom wholly effective.

The most certain relief to be found is by the medium of double glazed sash, with some 3 inches of air space between the two. This is naturally expensive, and both the outer and inner sashes have to be made absolutely airtight, or the scheme is not effective. All chinks, cracks and crevices must be calked tight or covered with strips of paper pasted on. The glass must always be carefully cleaned and dried on a clear, mild day, and it cannot be cleaned again without removing the inner sash. Exhibits do not appear to the same advantage when seen through two panes of glass, and, furthermore, it is almost impossible to have the inner sash in large lights owing to possible breakage in the frequent handling necessary; the sash rails necessarily interfere with the view.

The ventilation system is advocated by the big dry goods stores as being a simple, clean, practical, and effective method of keeping glass in its usual condition in cold weather, and is based on certain inflexible physical properties of the atmosphere, which are well established in science and by some methods easily applied. The Dry Goods Reporter says: If the temperature inside a building is 70 degrees and it is 32 degrees outside, the temperature of the glass will be about 50 degrees. If the air inside was only 60 per cent saturated the glass would become fogged with moisture at this temperature. If the temperature was 6 degrees below zero outside, and 70 degrees above inside, the temperature of the glass would be about 32 degrees. This would cause the windows to frost, and any lower outside temperature would add to the accumulation of ice.

To prevent this the glass must either be warmed to a degree which is above the saturation point of the surrounding air, or the surrounding air must be made so dry that it will not deposit moisture on the glass at the temperature of the latter. The particular ventilation system advocated provides for a heating apparatus and the show windows to be inclosed. This is now customarily done to keep dust and dirt off the goods on display, but is especially necessary for retaining the heat with this system. The temperature within the inclosure can be raised to any degree necessary, according to the atmospheric conditions.

For example, the glass in an ordinary 20-foot front will take up about 13,500 heat units per hour in zero weather. If the inclosed window space is to be kept at 70 degrees the air admitted from the heating apparatus must be about 90 degrees. The apparatus employed to do all of the above consists outwardly of a steel box about 4 feet square and 6 feet high, with a small blower and direct connected electric motor on one side at the bottom. It is a compact unit mounted on one base. Air enters the top through a pipe connected to some convenient source of fresh air supply. On its course downward, induced by the fan suction, it passes through an air filter, which eliminates the dust and dirt from the air. It then comes in contact with the heating surface of the steam radiator. After passing over the radiating surface it strikes a fan, by which it is discharged through a bell-mouthed pipe directly onto the glass. In the floor of the window are long, narrow registers, as close to the sash as possible, for the entrance of air, while in the back of the inclosure there are other registers to allow the air to escape.

In new windows or windows that are to be remodeled another style of ventilation may be installed, which permits the cold air from the outside to enter at the base of the window and then escape through openings at the top. Then there is a newly patented window construction, in which the plate glass rests in a patented molding at the bottom of the window. In this molding is a series of holes that permit not only the air to enter into the window, but any water in the window—from the cleaning of inside of glass, etc.—to escape outside. After this is installed there is no expense attached to keeping the windows ventilated.

There are several variations on the above patented device, which almost any one can put in without much expense and which will prove fairly satisfactory. In putting in the windows, whether the frames be of wood or iron, a row of ventilating holes should be provided below, extending all across the window front. These holes should be broad and set low down, with the idea of causing a wide current of air to enter the window, so that the same may spread all over the whole front of the window. Above the level of the panes, but still within the casing of the window, should be provided hinged ventilators to allow the heated air in the window to escape out into the street. A row of holes similar to those underneath will be insufficient, owing to the increased volume of the heated air, and on this account the upper opening must be of larger area, in order that the circulation of air within the window may be intensified. This ventilator must be mounted right at the top of the shop front, and open inward and upward, since otherwise it would oppose the outflow of air and thus lead to a mist on the upper part of the window. Furthermore, the inlet holes must not be surmounted by anything that can deflect the flow of air. The inflowing air must ascend close to the glass and escape without hindrance. This scheme is pretty near perfect for an inclosed window, but with any of these variations it is essential to keep heat from the window. Dry, cold air is necessary to prevent freezing under these schemes. Even lighted gas jets in the window will heat the air more rapidly than the ventilator can carry it away, the result being a deposit of moisture on the pane.

NOTES ON VANADIUM.

A PAPER dealing with vanadium was recently read before the Engineers' Society of Western Pennsylvania, by Mr. Kent Smith. From the discussion which followed we abstract a few notes. There is no difficulty in welding vanadium steel; the vanadium tends rather to help the welding than otherwise. It must tend to do that because it is an easily oxidized element giving a fusible oxide. There is no difficulty in getting a weld of about 90 per cent strength with vanadium steel, which is certainly not always the case with carbon steel.

As regards cost, the cost of vanadium alloy on vanadium content is $5 per pound. That sounds a truly alarming figure, but we have to remember that vanadium is a very powerful element and has to be used only in "homeopathic doses," the maximum quantity of vanadium necessary to be used being about 0.20 per cent or 0.25 per cent. It may be said that this seems a very small quantity, but we all know the enormous influence of 0.2 per cent of phosphorus. We all know the extraordinary results physically that are attained by suitably adding less than 0.1 per cent of aluminium, therefore, is it very difficult for us to accept logically the demonstrated fact that 0.2 per cent of vanadium is responsible for a very large amount of good?

Coming back to the question of cost. Vanadium is $5 per pound content; if the alloy used contained 25 per cent, the value of that alloy is about $1.25 per pound. From those figures it is self-evident, making all allowances, that there is no difficulty in producing vanadium steel at a cost fairly comparable to that of ordinary high grade nickel steel. Vanadium is a very easily oxidized element. It will take oxygen from solid oxide of iron, which at once accounts for some of the earlier published figures being so contradictory, since those figures were always founded on the fact of so much vanadium being *added*, and the assumption that therefore the steel contained that much vanadium. If the steel was at all oxidized an equivalent amount of vanadium disappeared in the slag. But there is no difficulty in producing a steel that is practically non-oxidized, and there is no doubt that vanadium owes a certain amount of its beneficent action to the absolute removal of the last trace of oxygen. This trace need only be small, as if vanadium be carefully added to a thoroughly well worked down steel, the amount added and the amount which the steel is found to contain are fairly closely allied.

From a number of practical trials made and still being made in noted arsenals, there is no doubt that vanadium gun barrels in resisting erosion are a great deal better than ordinary carbon steel barrels. That I ascribe to the fact that these barrels are truly "sorbitic" in structure. I do not say that the steel is any more dense, because if the carbon steel is well finished it has a density as good as you can obtain by the addition of any alloy. But "vanadium" carbide is so well emulsified or "spread" through the steel that it seems to form a kind of protective coating and prevents the erosion that happens if you have a steel whose structure is more or less patchy. I believe the advantage is due mainly to these "mechanical" reasons, and in vanadium steel we have a great advantage, as we cannot by any tempering of ordinary steel get the sorbite "emulsified" so thoroughly and in non-weakened ferrite.

The addition of vanadium to ordinary pure dead mild steel practically produces something akin to Swedish steel and we all know that Swedish steel is very much better for rivets than is ordinary pure open-hearth steel. They may both show similar results on the tensile machine and in the ordinary "complete" analysis; but the vanadium steel will stand work much better in service, and will make a rivet "live" very much longer. It is perfectly feasible to finish an ordinary open-hearth heat so that it is practically free from oxygen, and you will get about 90 per cent of the vanadium added to such steel. It is quite a simple matter to get 90 per cent of the added vanadium in the steel, and you can do it perfectly in the one ladle. Certainly, in my practice in Europe I used two ladles in order to thoroughly deoxidize the steel in the first ladle, as I found that the increased economy and regularity obtained more than paid for the extra trouble in the lining of the second ladle. One should deoxidize the steel very thoroughly before adding the vanadium and it is easily feasible to so deoxidize in the furnace. Of course, if we add the manganese in the furnace, especially the basic furnace, we have to look for a greater manganese loss. Where I use two ladles I do all the deoxidizing in the first ladle, then tap through a large nozzle into the second ladle. It is most practicable to do this where one is dealing with large-sized casts, as you have no heat reserve to warrant using two ladles when you have only two or three tons. With a 15 or 20-ton cast it is practically easily possible to use two ladles, tapping very hot into the first ladle and seeing to it that the nozzle and stopper of the first ladle are big enough.

CARRIER PIGEONS THROUGHOUT THE CONGO.

THE Ministries of War, and of the Colonies, and the Paris Geographical Society are interested in the attempt to establish the services of carrier pigeons throughout the Congo. The funds have been appropriated to establish four pigeon houses 120 miles apart, making a line of communication 360 miles in length. One of these houses was put up at Brazzaville on the upper Congo in 1906, the pigeons being brought from France. The experiment worked so well that the service is now to be introduced at a number of other stations. The installation of carrier pigeons is to supplement the telegraph service which has not been entirely satisfactory, although it is still being extended between some of the more important stations. Owing to the great distance covered and the difficulty of travel, interruptions in this service frequently occur, owing to the natives stealing stretches of wire, and to the meddling of elephants. Elephants seem to take especial delight in pulling up telegraph poles. In addition to the cost of re-establishing the lines, there is the unavoidable suspension of communication for weeks at a time. It has been proved that imported pigeons do well and retain all of their instinct for regaining the homes from which they have been removed. They are apparently in no danger from birds of prey, and their young thrive. These pigeons taken 120 miles from their home will, in the Congo, regain them in about 2½ hours. Not a single letter has gone astray if sent in duplicate by two birds released together. It is not intended to force them to flights of more than 120 miles, but it is calculated that a letter sent from one station to another by release of birds, will be carried about 600 or 700 miles during the hours of daylight of a single day.

CHINESE EXPORTS.

THE principal exports of China are tea, cotton, cassia, camphor, coal, silk and its products, fibers (ramie, jute and hemp), pig iron, iron ore, antimony, lead ore, tin, zinc ore, skins, oil-seeds, wools and straw braid. The British Empire takes 22½ per cent of the empire's total exports, France 19 per cent, Russia 14½ per cent, while the United States and Japan take 13 per cent each.

The quantities representing some of the exports for 1906 are given below:

Tea, pounds	187,217,000
Cotton, pounds	102,505,600
Camphor, pounds	1,977,000
Cassia, pounds	8,475,900
Coal, tons	301,422
Fibers, tons	22,245
Oil seeds, tons	107,970
Skins, pieces	988,147
Straw braid, pounds	14,655,000
Wool, pounds	3,952,700

PRUSSIAN RAILROAD TESTS.*

THE ORANIENBURG TRACK.

BY WILLIAM MAYNER.

ALTHOUGH railways have now existed for nearly eighty years, yet a most important question as to the construction of the track is still open. In Germany the railway lines were taken over by the government from a number of private companies, which had prevented the carrying out of one uniform system. Economic considerations have also delayed the making of experiments.

The number of experts who have devoted their time and experience to the construction of the railroad track is small nevertheless, and there are also difficulties in the solution of the question, which, however, has not been neglected by the German Railway Administration and which has formed a subject of discussion in the different railway congresses. To begin with, the climatic conditions are very different. For instance, in England there is a temperate, damp climate, but the railway track is seldom exposed to the change between frost and thaw; whereas on the continent of Europe the difference in the temperature and the humidity of the air is very great, especially in the spring. It is therefore easier to keep the track in good order in England than on the Continent.

Theoretical opinions do not suffice to judge the various circumstances which influence the railway track and the effect on wheel and rail. It is a very long time on tracks which are little used before the destruction of the track has so far advanced that its condition contributes useful hints as to its construction. On tracks largely used there is often a lack of time for making the necessary observations and measurings. It is also difficult and dangerous to make frequent new trials. It has therefore been the desire of railway engineers to build a trial track on which there is no traffic, merely for experiments as to the construction of the track.

Such a track has been constructed by the Berlin Railway Administration in its forest near Oranienburg, which is connected by a line with the railway passing that town. The trial track has a length of 1,750 meters (1,914 yards), consisting of two straight tracks of 250 meters (273 yards) each running parallel in a distance of 400 meters (437 yards) connected at each end by curved tracks of 200 meters (219 yards) radius and 628 meters (687 yards) long. At curves the outer rail is 125 millimeters (4.9 inches) higher than the inner and the gage is increased by 24 millimeters (0.95 inch). Four different kinds of tracks have been used.

The railway lines are placed alternately on wooden and iron sleepers, the wooden sleepers consisting of pine, beech, or oak. They are so divided that on four divisions of the lines of equal length the different kinds of sleepers are used. The following material is alternately used for the roadbed: gravel, gravel from rich beds, broken stones of three kinds. The subsoil on the whole consists of sand; thus the trial track represents well the various kind of tracks. Rails of different sizes have been connected by different systems at the rail joints, and rest partly on iron and partly on wooden sleepers lying sometimes on gravel and in other cases on broken stones.

The trials on this railway track are especially to be used for tests of the following three questions:

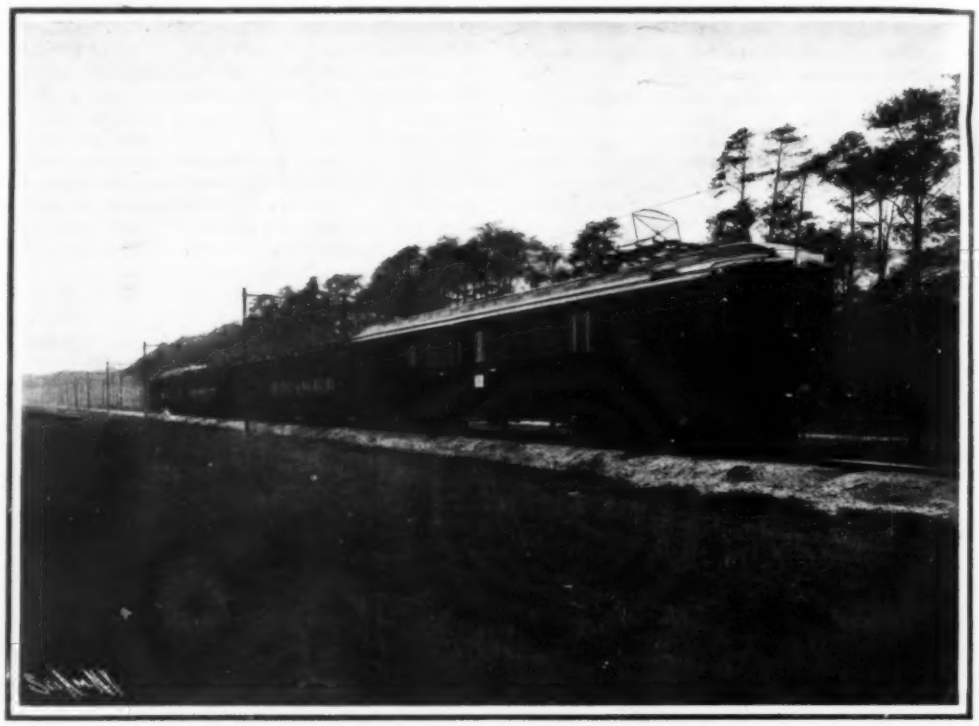
1. The effect of the material of the track and the form of the sleeper upon the correct perpendicular and vertical position of the rail.

2. The examination of the various arrangements of the rail joints.

3. The wear and tear of the top of the rails.

It is important that only arrangements of the same kind are compared; for instance, if various arrangements of the rail joints are to be compared with one another, the respective sleepers and track materials must be the same.

If sleepers are to be compared with one another, arrangements of the rail joints and track material must be the same, also rail-joint arrangements and sleepers must be the same if different track materials are to be compared.

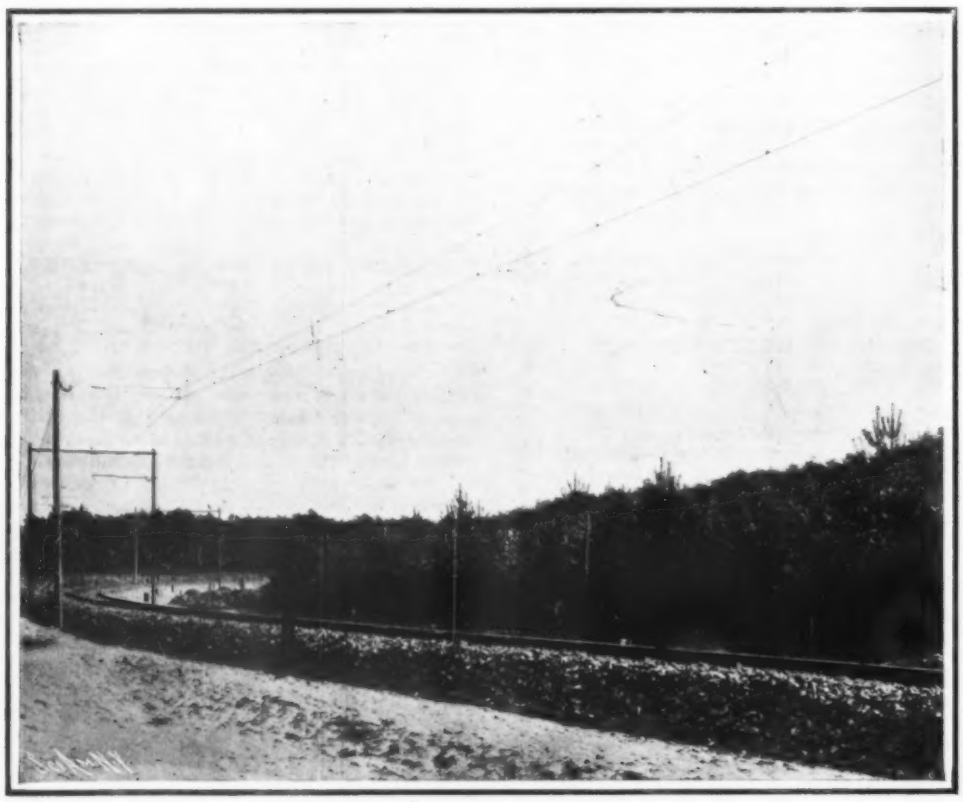


THE ELECTRIC CARS.

The first use of this line was made in December last year by two electrically-operated cars of a little over 52 tons each. The motors exert a maximum power of 125 horse-power, 110 horse-power, and 45 horse-power, continuous effort, which, however, is to be increased to 60 horse-power. It will then be possible to attach some luggage vans to the two cars and to move the train so formed of 170 tons weight at an average speed of 50 kilometers (31 miles) per hour. The electricity is obtained from the electric works of the town of Oranienburg, which is about 3.5 kilometers (2 miles) distant.

The train has no operator, the electric current being put on or off from a little station house on the track. With the exception of Sundays and holidays the train is to run about twenty hours a day. By a clockwork device the number of journeys are controlled, from which the burden carried over the track can be calculated. The perpendicular inclinations are measured very simply, by placing on both sides of the lines, about 50 meters (164 feet) apart, also about 5 meters (16 feet) before and after every change in the material of the roadbed and the iron and wooden sleepers, posts with a notch at the head, over which a lath is placed horizontally. Horizontal changes are gaged similarly. To measure the perpendicular alterations in form at the end of the rails a flat steel ruler one meter long is used, which is placed on the rails at the joint. By means of wedges the inclinations at the end of the rails are determined. Besides these lasting changes, the changes under the passing burden, changes in the gage of the rails and the connections, etc., are controlled by special instruments. The amounts spent for the maintenance of the different parts of the line are separately entered so as to compare their cost.

For such trial tracks it is of course a great object to put as great a weight as possible on to the track, to ascertain as soon as possible the quality of the different arrangements. It is natural to make comparisons with lines with a very great traffic, in order to ascertain what the least is that must be expected. Such a line with great traffic is the suburban line of Berlin, on which 263,000 trains ran from April 1, 1904, to March 31, 1905, which amounts to 360 trains per rail. The average weight of the trains was 185 tons, so that the weight carried over each rail per annum is equal $\frac{263{,}000 \times 185}{} = 24{,}300{,}000$ tons. On the trial track the train goes 570 times the round of the



VIEW OF THE TRIAL TRACK.

* A synopsis of Prof. Frahm's report of the official experiments on the trial track at Oranienburg.

track within a working day of 20 hours at a speed of 50 kilometers (about 31 miles) per hour. Assuming the train to weigh 170 tons, there would pass during 300 working days of the year over every part of the line a weight of 300 × 570 × 170 = 29,000,000 tons, that is about 20 per cent more than on the suburban line. For the examination of the track it is of course desirable to put a still greater weight upon the rails, which of course can be done at any time. The trial track is first of all to be used for the test of roadbeds, which, however, does not of course exclude other trials, for instance, electric motors, signals and other safety arrangements. Experience can also be gained as to the effect of the different kinds of motors on the track, which can be used for electric railways.

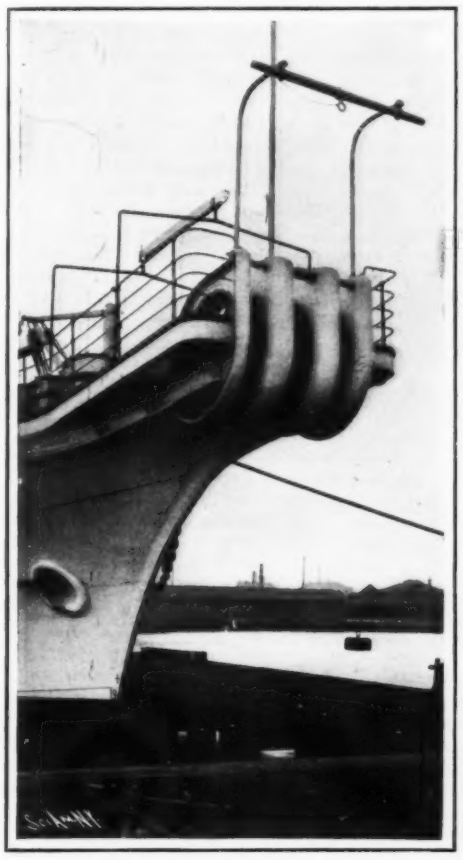
It is believed that there is a good chance in Germany for American railroad material and supplies, as well as safety devices, provided offers are made through the proper channel, that is to say, through a German agent or firm, as it is well known that the German government departments never purchase from citizens or corporations of other nationality directly, but, as stated, only through a German intermediary.

A NEW CABLE SHIP.

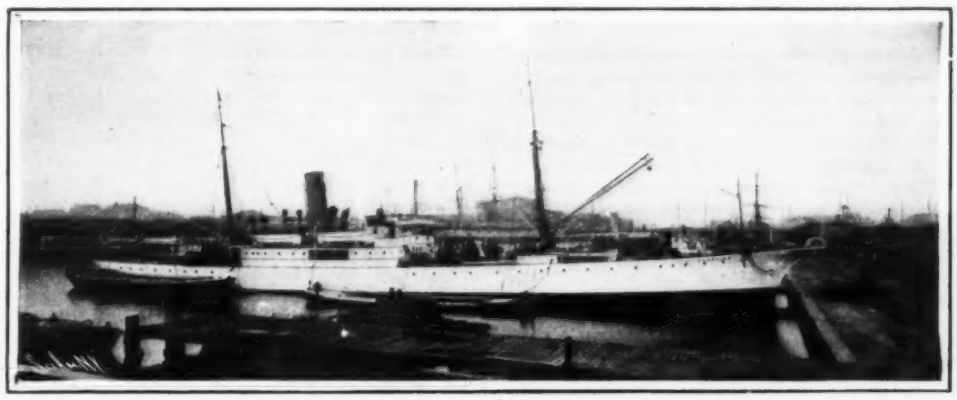
MACHINERY FOR LAYING SUBMARINE CABLES.

BY FREDERICK C. COLEMAN.

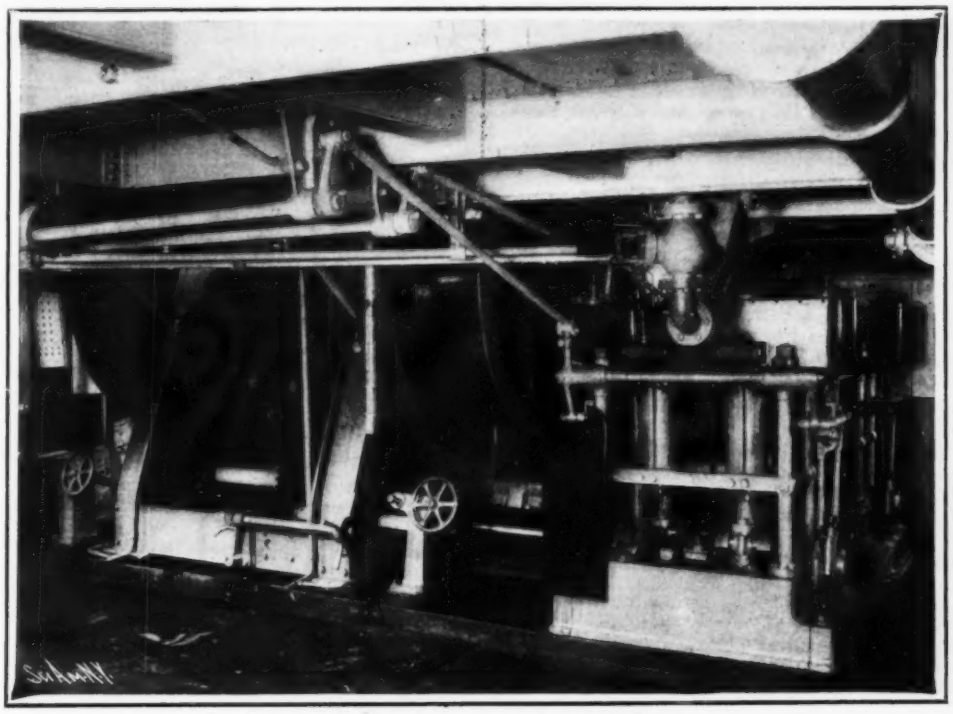
A NEW cable ship, built in England, has just been stationed at Callao, Peru. She is commissioned for three years, during which time she will be occupied in laying and repairing the Central and South American Telegraph Company's cables on the western American coast. The vessel, named the "Guardian," has a length between perpendiculars of 270 feet, a length over ball sheaves and stern of 293 feet, a beam of 36 feet, and a depth to spar deck of 24 feet 9 inches. The total deadweight capacity of the vessel is made up of coal 700 tons, cable 665 tons, cable machinery 50 tons, cable stores 60 tons, fresh water and provisions 100 tons, spare gear 15 tons, and a balance is allowed of 160 tons for stores, refrigerating plant, etc., making a total of 1,750 tons. The "Guardian" is provided with twin screws, which are driven by two sets of triple expansion engines. The diameters of the high, intermediate, and low pressure cylinders are 15½, 25, and 43 inches respectively; the stroke is 30 inches. Steam is raised by two single-ended marine-type tubular boilers with a grate area of 102 square feet and total heating surface of 3,800 square feet, fitted with forced draft and designed for a working pressure of 180 pounds. Her speed is 12½ knots, and she carries a crew of 57. The vessel is provided with four cable tanks of different sizes, the two largest having inner tanks for smaller cables. Each tank has an inner cone and one of these is used for fresh water which, together with that contained in a tank formed by the inclosure between the bulkheads of the two shaft tunnels, provides an ample store for the ship. A dynamo in the main engine room supplies electric light to the whole ship including the searchlight on the bridge, which is required for looking out for cable buoys and marks at night. The powerful picking-up and paying-out machinery is fixed on the main deck. This gear is a new type and is what is known as a double combined picking-up and paying-out machine. The engines are arranged on the starboard side of the machinery, which is found to be an advantage over the old system of having one engine at each end fore and aft, as it leaves more space for getting at the working parts. The two engines are double-cylinder high-pressure with cylinders 8 inches diameter and 8 inches stroke. Each engine will develop 110 brake horse-power with a steam pressure of 150 pounds or a total of 220 brake horse-power which may be utilized to drive one or both machines. Owing to the necessity of starting under heavy loads, this type of engine is supplied in preference to the compound type.



THE SHEAVES OVER WHICH THE CABLE PASSES.



THE NEW CABLE SHIP, THE "GUARDIAN."



THE PICKING-UP AND PAYING-OUT MACHINERY.

A NEW CABLE SHIP.

The gear is so designed that either engine will work each or both machines in a forward or reverse direction and the power of both the engines can be combined to drive either one or both machines forward or reverse. With the gear so arranged the risk of a total breakdown is reduced to a minimum. With the two engines in gear the picking-up machine will haul in cable against a strain of 25 tons at one knot per hour or 10 tons at 2½ knots per hour: the paying-out machine will lift 10 tons at 2½ knots per hour or 6¼ tons at 4 knots. Each machine by an arrangement of reduction gear can be driven at a higher or lower ratio of speed. A sliding gear wheel is provided on an intermediate shaft by which the two systems can be connected together, so that either engine can drive either drum through any of the four different gears. The cable drums are 5 feet 8½ inches diameter and 1 foot 8 inches wide between the flanges and are made to overhang and run loose on their shafts. Each is driven by a pinion gearing into an internal gear ring attached to the drum, the pinion sliding in and out in an axial direction. As the brake ring is attached to the drum it is only necessary to have the drum and holding-back gear running when paying out, thus saving the wear and tear of the whole machine and avoiding the noise and rattle of the gearing. Another advantage in this arrangement is that the drum shaft being fixed, acts as a tie and greatly strengthens the frame, and the shaft which carries the intermediate wheel for coupling the two systems together as mentioned above, being fixed in the frame, also acts as a tie to the same. Lubrication of the drum bearings is effected by large grease cups on the fixed shaft which can be screwed up while running. The position of the internal gear rings on the drums allows of the pinion shafts being supported by outer bearings, a feature of great importance, inasmuch that the provision for the sliding pinion prevents the inner bearing being close up to the pinion when in the driving position. The main brakes consist of steel straps lined with elm blocks encircling the brake ring, on which they are made to close by means of a double-threaded screw actuated by hand-wheel through the medium of a worm gear, which gives a very fine regulation for the lighter strains and at the same time providing enormous holding power when necessary. To the back of each strap is fitted a water service pipe, and the water, supplied by a Worthington pump, is directed by nozzles placed at intervals between the joints of the brake blocks and right on the face of the drums, forming an efficient cooling arrangement for the brakes when

paying out. Both brakes can be combined to act on one drum, where necessary, to give extra holding-back power. All the gearing is of cast steel. The "hauling-off" and "holding-back" gears are mounted on the spar deck and are each driven by a silent saw-tooth chain from a shaft carrying a pinion, which can be made to slide into engagement with the internal gear ring on one of the main drums. They are provided with a friction brake and "free wheel" arrangement so that they are driven in one direction only, i. e., the picking-up direction, then revolving with a slightly higher peripheral speed than the main drum and thus keeping the cable tight. When paying out, however, they are held back by the brake and allowed by the "free wheel" to revolve with a slower peripheral speed than that of the main drum. When, therefore, it is necessary on a picking-up job to reverse and pay out a little slack, the gear acts quite automatically. This is a great advantage over the older system, where it was necessary to put a clutch in and out of gear. A screw gear is also provided for traversing the haul-off sheave across the face of the drum to suit either "inside" or "outside" lead, and this can be worked while the machine is running. Practically the whole of the actuating gear is operated from the spar deck. The main brake wheels, steam stop valves, engine reversing gear, and drain cock handles are all within reach from one position.

The hand wheels for putting the various gears into action are all situated close by, as well as the levers for the putting into action and regulating of the hauling-off gear. It is only necessary to go below to couple the two engines or to adjust the fleeting knives when the cable is being first passed round the drums. There is in addition a steam hauling gear for putting the cable into the tank, a steam sounding machine, and three improved dynamometers, two of which are placed forward and one aft. The ones at the bow will register from a delicate strain on the cable of 6 or 7 hundredweight to a heavy strain of 25 tons, while the stern dynamometer will register from 5 hundredweight to 10 tons.

There are three bow sheaves 4 feet 3 inches diameter over flanges, each fitted with cast iron guards which extend almost round the flanges, and one sheave wheel at the stern 3 feet 3 inches diameter. Galvanized gratings and rails extend to the extremities of the sheaves.

ACTION OF SEA WATER ON CONCRETE.*

A SYMPOSIUM AND ITS RESULTS.

ABOUT forty circulars were sent out to as many different members of the Association of Railway Superintendents of Bridges and Buildings requesting information as follows:

1. Concrete made in air and sunk into sea water.

2. Concrete deposited direct into sea water.

3. What effect has the rise and fall of tide water on concrete?

4. What effect has the frost on concrete where the tide rises and falls on concrete?

One of our New York members writes as follows:

1. Where there is no ice formation, concrete, if made in air with fresh water and then sunk into sea water works well, but shows a tendency to disintegrate slightly on the faces between low and high-water levels.

2. I would not deposit concrete direct into sea water. Where the salt water permeates the whole mass of the concrete the faces disintegrate faster than where the concrete is mixed with fresh water, is made in air and then sunk into position in the sea water.

3. Between low and high water the faces of the concrete show a tendency to disintegrate.

4. Where there is severe cold and a large ice formation concrete exposed to the rise and fall of the tide will disintegrate on the exposed faces. (In my experience to a depth of ⅛ inch to ¾ inch.) If this disintegrated portion is faced up with cement mortar each spring there will be no further trouble until the ice goes out the next winter. In my judgment bridge piers and abutments should be built from about 2 to 3 feet below extreme low water to the top of the masonry, of granite ashlar dressed smooth on the faces exposed to the ice and salt water and backed with concrete.

Another New York man writes as follows:

1. Mix it dry and put it through chutes into the water; never mix with water before putting into bed.

2. Concrete deposited into sea water will be covered under "1." Would say that in the vicinity of New York there is very little of this done. Most of the concrete handled at this point is made into blocks and sunk to the depth required and handled by divers. This seems to be the better method and gives more satisfaction than trying to put it in in any loose form.

3. The rise and fall of the tide seems to have no effect whatever on the concrete blocks when placed as I have mentioned above. The frost does not seem to have any appreciable effect on the concrete.

The replies from the vicinity of Boston favor the concrete deposited direct into sea water, as the following will show:

2. Concrete deposited direct into sea water.—So far as I know, this gives perfectly satisfactory results if the material and method of work are right. The cement should contain not over 2 per cent sulphuric trioxide and a low content of magnesia; the sand should be good and crushed stone should be used rather than pebbles; the mixture should be not leaner than one, two, and four, and it should be deposited either with a tube or a bucket on the O'Rourke pattern, which opens wholly inside the bucket, making practically a closed tube for the concrete to drop through. In using a tube the first charge is bound to be washed, hence it is best to begin operations each morning out in the area well away from the forms, so as not to have washed concrete on the outside of the mass when finished. This is difficult to impress on the workmen, as they always want to start operations at one corner. At times there is trouble from the milk of lime, or "laitance," as the French call it, which is too heavy to float away in the water. If it collects more than about 3 inches thick, it should be pumped off or otherwise disposed of; it will not harden, and if covered into the mass will make a weak section. If concrete is properly deposited in pure sea water it sets even stronger than in air, but I prefer to have a stone masonry facing between high and low water. If concrete is exposed to the sun's action between tides it must be extraordinarily good to withstand the combined action of all the forces acting to disintegrate it.

There are a large number of piers around Boston built by methods similar to this, and there has been no failure or trouble with them due to lack of integrity of the concrete. It will be noted that above low water the pier is faced with stone. Attention is always given to the chemical constitution of the cement used, and it is tested for soundness in sea water by the so-called barrel test. This consists of placing a small barrel in a large cask filled with sea water, and then filling the small barrel with cement through a small tube. After twenty-four hours the cask is dumped and the barrel cut off from the concrete. If the cement is suitable to use, the concrete will be quite hard and will require a pick to break it up. Analysis for sulphuric acid should accompany this test, as the barrel test alone will not prove durability. A remarkable instance of concrete made in air and sunk into sea water (*vide* item 1) has just been executed at Brunswick, Ga., where reinforced concrete piles 18 inches square, 41 feet long, tongued and grooved, have been placed for a pier facing. These are rodded back to a double row of timber piles and the pier is filled solid with earth. Timber fender piles are driven in front of the concrete face to take the blows from vessels. The concrete piles are sunk by water jet through a pipe cast in the center of the pile.

3. All of the replies seem to agree that concrete should be faced with granite above low water, as the rise and fall of the tide has a tendency to disintegrate the concrete.

4. All of the replies seem to agree that frost and ice formation, where tide rises and falls, has a greater tendency to disintegrate the concrete.

The chairman has made it a particular object to examine quite a number of structures of concrete in tide water in the vicinity of Boston, and has found that in every structure examined disintegration was taking place with more or less rapidity between high and low water—in some cases, notably the arches under the piers at Charlestown navy yard, this disintegration being to such an extent as to seriously affect the stability of the work. He has been informed by those who are constantly on the work at these different places that this disintegration was considerably more rapid in cold weather when frost was experienced than at other times, although disintegration occurs even in warm weather. In some cases the concrete scales off in quite large patches, but in most of these cases it comes out in small particles, so that the stones which form a part of the concrete were left projecting out from 1 inch to 2 inches beyond the general surface, or until such time as the weight of the stone would offset what little holding power remained to the concrete at the inner point of the stone.

The chairman finds the same trouble with granite above low water. He has examined several places where the mortar has disappeared in the joints and had to be repointed after three or four years. He has also looked over a concrete pier on the Providence River at Warren, R. I., which was built about twenty-five years ago with a mixture of sand and cement of about one to three. This concrete is in a good state of preservation, except between high and low water, where it is worn away in places from 4 to 8 inches, which looks as if it was done more by the current and ice as the tide ebbs and flows, rather than by the combined action of frost and tide water rising and falling. The current at this point runs at about the rate of eight miles per hour, which is pretty fast, and causes quite a whirlpool as it passes the pier.

It is the opinion of the committee that item "2" is the cheapest and best method of sinking concrete into sea water, and if properly mixed with proper material and properly handled and faced with granite above low water, that with a suitable number of headers to make granite masonry firm, it will do good service. The committee also thinks that it would add to the stability of the granite if the joints were calked with lead.

* From the report of a committee to the Association of Railway Superintendents of Bridges and Buildings.

FLAME AS A MOTIVE POWER.*

By DUGALD CLERK.

MORE than 2,000,000 horse-power of stationary gas engines operated by flame are in use in the world, and probably automobile engines account for at least 1,000,000 horse-power more. The working fluid of gas or petrol engines is formed by flame produced by the combustion of inflammable gas or vapor and atmospheric air. The power is obtained by several different methods. First: By filling a vessel or cylinder with a mixture of gas and air, and igniting this mixture, a slight explosion is caused, and the excess pressure blows off through a valve. The temperature of the flame is very high, and so when it cools the pressure in the vessel is reduced below atmosphere. This reduction of pressure may be utilized by means of an engine operating by atmospheric pressure and discharging into a partly vacuous vessel, or by a piston moving into the vacuous vessel. This method may be called the explosion-vacuum method. A modification of this method exists which may be called the flame-vacuum method. In it the explosion is dispensed with. Second: By admitting a charge of atmospheric air and inflammable gas or vapor at atmospheric pressure to a cylinder containing a piston, cutting off access to the atmosphere and the gas supply, and igniting the mixed charge, a mild explosion occurs; the pressure rises in the cylinder, and the piston is driven to the end of its stroke. Third: By supplying to a cylinder containing a piston a mixture of inflammable gas and air in a compressed state, and then igniting that mixture, a motive power can be obtained. Fourth: A cylinder is supplied with gas and air under pressure, but the mixture is ignited at a grating or shield as it enters the cylinder, and so the pressure in the cylinder never rises above the pressure at which it is supplied. The power here is obtained without any increase in pressure, and is due to the fact that a small volume of cool mixture, when inflamed, becomes a larger volume, so that although a pump may be used to compress it the expansion in the motor side is greater, although at the same pressure as that in the pump.

The four modes of action, and combinations or modifications of them, include all the fundamental methods used in obtaining motive power from flame which have been attempted by mankind for the last hundred years.

* From an address before the Royal Institution of Great Britain.

LOSSES OF EFFICIENCY IN STEAM TURBINES.

THE best results that have been obtained from large turbines show that about 70 per cent of the available energy in the steam is converted into brake horse-power, according to Hon. C. A. Parsons in a paper read before the Royal Institution of Great Britain. The chief losses of efficiency in all steam turbines are due to three principal causes: first, to skin-friction of the steam coursing at high temperature through the small openings between the blades; secondly, to unavoidable leakages; and, thirdly, to eddy-current losses arising from insufficient blade velocity and errors of workmanship.

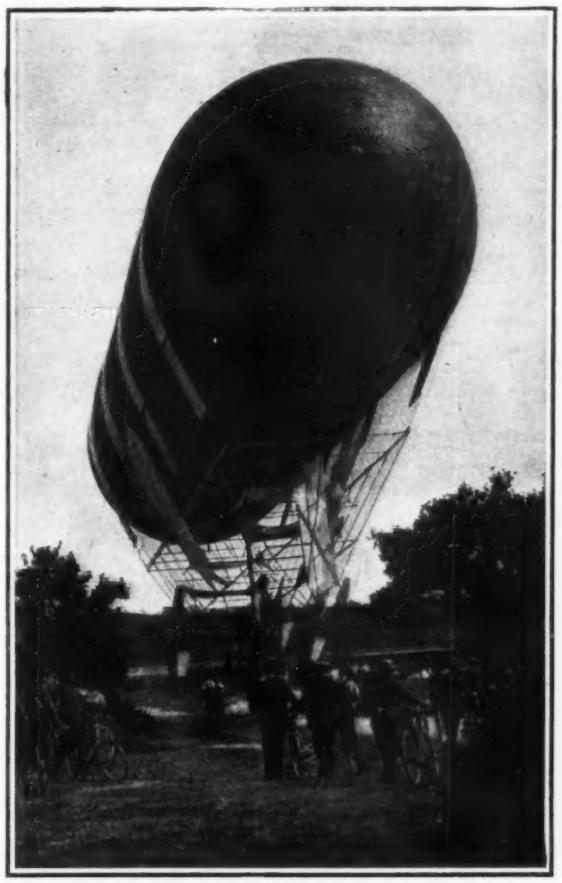
The loss due to the friction of the steam in a turbine is reduced by superheating, and thus partially removing the fluid frictional loss arising from the drops of condensed water mingling with the steam. In some cases this gain in efficiency is worth the extra cost of the superheater, but, unless intermediate superheaters are used, initial superheat cannot be raised high enough to maintain dryness throughout the major part of expansion without destroying the turbine.

DEFECTS OF THE FIRST BRITISH AIRSHIP.

THE NEED OF HARBORS FOR AERIAL CRAFT.

BY OUR LONDON AERONAUTICAL CORRESPONDENT.

ONE must deal generously with the defects of the "Nulli Secundus," the first British military airship, which was wrecked last October near London, for they were so obvious to the student of aeronautics that it was merely a question of time for them to be revealed to the general public. Under the peculiar circumstances governing the production of the vessel, they were, however, unavoidable; and needless to say, the constructors had no other course than that followed. Lack of funds and official encouragement compelled them to use the materials close at hand. Thus a crude gas envelope, designed some five years ago, and long before the French had evolved a more scientific type of vessel, had to be made use of, and to this ancient but worthy craft were fitted engines which were obviously under-powered for the work in hand. It was as if we took a sturdy old canalboat and engined her with a motor boat's engine.



END VIEW OF THE AIRSHIP, SHOWING THE PROPELLERS, RUDDER, AND PLANES.

Yet "Dirigible I." made its trip from Aldershot successfully, though of course it was favored by a most obliging breeze, which almost rendered the engines superfluous. But when the wind had to be faced on the return journey, it was at once realized that the huge envelope, with its clumsy shape, and its heavy burdens, was too much for the engines. It was in this respect that a scientifically designed craft like the "Patrie" would have scored, as she would have been able to make headway against the breeze, and would have undoubtedly got back to harbor at Farnborough on Saturday evening.

The power installation of "Dirigible I." is not in accordance with advanced continental practice, where for this branch of the work skilled motor engineers have been called in; and they have fitted specially designed motors to their crafts. The engine of "Dirigible I." was bought at the Olympia motor show in November, 1906, and though made by a firm of much experience in aerial motor work, it does not seem to have been specially built so as to give the requisite power for the work in hand. Then, again, the power transmission devices introduced would hardly meet with the approval of a motor engineer, and they struck the critic as being very crude and amateurish as compared with the work to be seen on the French and German vessels. We cannot expect, however, to accomplish in a few months what our rivals have taken years to arrive at under far more favorable circumstances.

When the writer calculated the speed of "Dirigible I." on its first trip at Aldershot, and on its run to London, it was obvious that the propellers were unable to drive the unwieldy vessel with any great speed, and the fact at once established itself that an adverse wind of even medium force would prevent any headway being made. This indicated a great danger, especially in our climate and at this season of the year, and it was an imprudence to venture so far afield on a favoring breeze, more particularly as London is yet without its airship harbor. Before any further extended straightaway flights are made by British airships, the authorities will have to consider the problem of providing London and other cities with shelter harbors for the vessels.

"Dirigible I." fulfilled the first essential of an airship, in that its gas bag was marvelously reliable; and in its method of construction the British government have a most valuable secret. It lacked the other great essential of reserve propelling power, and this led to its undoing. With a better shaped gas envelope, which did not offer such resistance to the air, the 50-horse-power 8-cylinder "Antoinette" engine would have sufficed for the vessel, particularly if the more effective cooling arrangements and propelling gear used on the French airships had been employed.

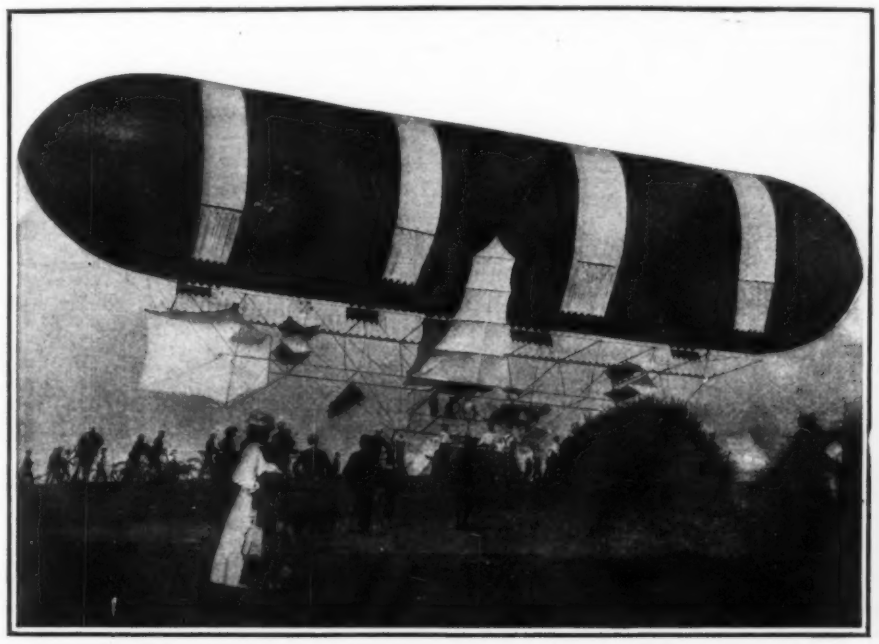
The aeroplanes and masses of cordage were another cause of trouble, for they absorbed an enormous amount of moisture, and quite deprived the vessel of its necessary buoyancy. The best types of French and German vessels are far more trim, and have nothing like the same amount of absorbent material in their construction. Inventors of airships and aeroplanes in these isles usually forget that ours is a very damp climate, and that the fabrics they use are quite unfitted to be employed in damp weather. The point is of vital importance; and had the builders of "Dirigible I." given it due attention, the vessel might have risen from the Crystal Palace between Saturday and Thursday, and made a successful dash for its harbor at Aldershot. Our rivals have not overlooked the matter, and one finds light metals extensively used, while there is a minimum of the cordage and planes which proved the undoing of "Dirigible I."

Disasters far more serious have occurred to many French vessels; and two of the Lebaudy ships have been wrecked. In almost every case the accident has been due to squalls when the vessel was being maneuvered close to the ground, and they all illustrate the truism that an airship is safest when in the air. Had "Dirigible I." broken clean away from her moorings and gone aloft, she would have remained up for an almost indefinite period, so staunch was she, and thus she might have gone far out to sea if nobody had been on board to bring her down. But with her crew on board, the vessel need have feared no storm so far as riding it out was concerned.

Lashed to the ground, she ran considerable danger in the sharp wind which sprang up; and if the sappers had not been so prompt, the vessel might have done herself far more injury than that actually sustained. Had the authorities evinced foresight in constructing an aerial harbor near London, the vessel could have been sheltered there in complete safety; and I urge that if we are to go on with the development of the military airship, we must at once make provision of this kind, or other good vessels of our aerial fleet will go to pieces. Col. Capper and his staff have worked wonders in getting "Dirigible I." in the air, and the trip to London town ranks as a very bold achievement, for no one knew better than Col. Capper the great handicap under which he worked.

It was unfortunate, after such a promising debut, that the vessel should have met with mishap, but, as I have endeavored to show, it was inevitable, under the prevailing condition of things.

Imitation Eburin.—A mixture of bone dust and albumen is composed in molds to a heavy pressure and at the same time, to a very high temperature. The eburin thus obtained is very hard and can be used in part as a substitute for ivory.



THE FIRST BRITISH MILITARY AIRSHIP "NULLI SECUNDUS."

Length, 100 feet. Diameter, 30 feet. Hydrogen capacity, 60,000 cubic feet.

SOUL-HOUSES IN EGYPT.*

A CURIOUS RELIGIOUS CUSTOM.

BY PROF. W. M. FLINDERS-PETRIE.

For many years past, pottery models of houses had occasionally found their way to museums, from the illicit digging of natives in Egypt. But nothing was known as to their original positions or dates, and they were so scarce that even the national museum in Cairo had not any example. During the past winter the work of the Egyptian Research Account, in Upper Egypt, has brought to light a large number of these models, and enabled the subject to be put on an exact historical basis of development.

The name of Asyut will be familiar to many, from the large American college there, which is so efficient an elevator to the native Christian population of Upper Egypt. In the desert cliffs of limestone at the side of the Nile valley are some vast tombs cut in the rock, beside hundreds of smaller burial chambers. And a few miles south of this is a similar set of rock-tombs at the village of Rifeh. These are all of the period of the Middle Kingdom, IX to XII dynasties, about 3700-3300 B. C. In front of the cliffs at Rifeh was a large cemetery of graves cut in a gravel shoal, on the foot plain which is formed by about half a mile of desert between the cliffs and the Nile-mud cultivation. This shoal had gradually been accumulated by wash from the desert hills during rare storm-bursts, perhaps once in a generation, or in a century. And the shoal had continued thus to grow, so that about 25 inches of gravel had been laid down in 5,000 years since the graves were cut, or half an inch in a century. The whole cemetery was thus covered with a purely natural unbroken sheet of gravel. On trenching through this, hundreds of graves were found, and though all had been plundered for valuables anciently, some fine objects were recovered, and the pottery models had been left behind unheeded in the search for precious metals.

The conditions here described explain how it comes about that the models were common here while very rare elsewhere. They were originally placed upon the surface of the grave, to give shelter to the soul when it came out in search of sustenance. In most cases the desert surface is wasting by denudation, hence the models in such positions were always exposed until entirely destroyed. Here the surface was accumulating, and within a thousand years the models, which were in lower situations, might have 6 or 8 inches of gravel and blown-sand heaped around them, enough to save them from further destruction. A few are quite perfect, most are partly broken, but the scattered fragments serve to show many details of interest. The ancient plunderers had done us one good turn, as in some cases models had fallen into the opened grave, and were thus sanded over and preserved intact.

FIG. 2.—TRAY OF OFFERINGS WITH SHELTER.

The origin of these models is in the tray of offerings. In very early time a mat was placed by the grave, and a pan of flour laid upon it for the sustenance of the dead. Such an offering was older than the dynasties, as the Hieroglyph *hotep* derived from it was used by Menes. The actual mat and pan have been found in later times, but the general system in the early dynasties was to carve a stone altar representing it, and place that by the grave. Then the poorer classes had the same imitated in pottery, as in the trays of offerings. (1) On these were hewn two tanks for water, with a drain from them, a bull's head, haunch, ribs, cakes, and a bird. These were felt to be but a cold and inhospitable accommodation for a soul that had come up from the shelter of the earth below, and so the next stage was to provide a shelter, apparently copied from the Bedouin tent. (2) Another stage was to provide a small hut like a sentry box, with sometimes a chair inside it. Then the portico was copied from the houses in actual use. (3) A raised cope was put around the roof of it, and a canopy or shelter from the sun was added above the water tank. In this latter shelter there are the holes for the posts, in which pieces of stick have been inserted for the present view.

The development of the upper story began with the roof coping and a stairway to give access to it. Then small shelters began to be added upon the roof. (4) In the example will be seen a veranda along the back of the roof, two large wind openings one on each side, with domed tops and clear roof spaces over them—originally four columns in front of the house—two open doors, and a door covered by a mat of maize stalks, which closed the storeroom. Soon the upper story developed as large as the lower, and then furniture began to be introduced. (5) In these the couch is placed on the ground in the front portico, to get the coolest air at night low down, while the chair is on the upper floor, to avoid the dust and heated air from the ground during the day. A later variety was attained by inclosing the whole front court with a high wall entered

FIG. 1.—POTTERY TRAYS OF OFFERINGS.

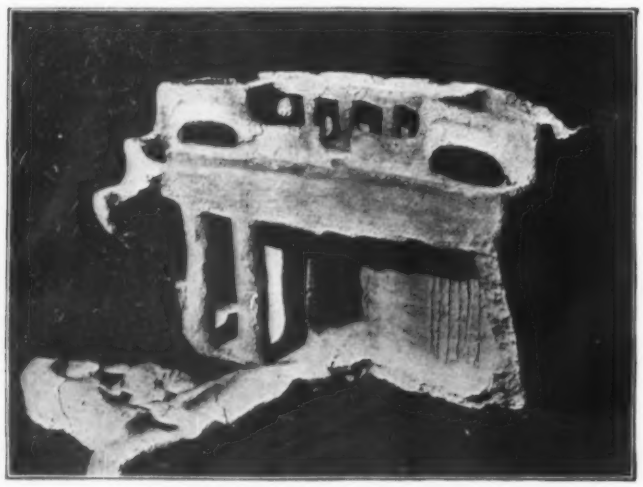


FIG. 4.—SOUL-HOUSE WITH UPPER STORY BEGINNING ON THE ROOF AND CLOSED DOOR TO STOREROOM BELOW.

FIG. 5.—SOUL-HOUSE OF TWO FLOORS WITH CHAIR COUCH AND STAIRWAY UP THE SIDE.

* Records of the Past.

by a doorway; the offerings were reduced or abolished, and the furniture was put into the back chambers. (6) The couch is here seen with the curved headrest, and the raised foot shelter, which seem to have been always used. A stool is also in the back chamber, one end of which has been broken away. At the left hand in the front court is the stairway which led to the upper story, now lost, and beneath the stairs is the woman making bread, with a large water jar at her side. The offerings are placed against the wall between two doorways.

FIG. 7.—FRAGMENTS OF WINDOWS, DOORWAYS, AND SERRATED WALLS OF MODEL HOUSES.

The minor details of the brick vaulting of roofs and floors, the floors carried on beams, the trap-door openings for stairs, the corn-bins on the roof, are also shown with all the little variations of devices and plans which were actually used. The windows sometimes had a hood-molding over them (7), and the front doors of the courtyard had a cornice top. The walls were, in the later models, finished off with a serrated top, and the same custom is found in the modern cemetery (8) close by the ancient graves. Examples of these models will be sent to the museums of Philadelphia, Boston, and New York.

From smaller tombs, weapons, ivory carvings, scarabs, and hundreds of other objects were procured. At Gizeh, also, to the south of the work of Doctor Reisner, a series of graves of the I dynasty were opened; they all surrounded a great burial, and can thus be dated to the reign of King Zet. From the stone vases, flint knives, ivory carvings, pottery, etc., it is seen that there was no difference of fashion between the southern and northern capitals at Abydos and Gizeh, but that the civilization was already completely unified in details of style, and one place did not lag behind the other as much as a single reign.

The Egyptian Research Account is now about to undertake the largest excavation yet attempted, in clearing the sites of the great temples at Memphis, which cover more than a hundred acres. There probably remain here the foundations of many temples, one below the other, as were found at Abydos, and statuary is likely to be as abundant as it has proved to be at Karnak. The great capital of the land through all its history still awaits research, and though more than a million dollars would be needed to clear the whole remains of the city, yet it is hoped to raise sufficient subscriptions to carry out the most important part of the clearance of the temples.

FIG. 3.—PORTICO WITH CANOPY OVER THE TANK.

FIG. 6.—SOUL-HOUSE WITH COUCH AND STOOL IN BACK CHAMBER. BREAD MAKER BENEATH THE STAIRWAY.

SOUL-HOUSES IN EGYPT.

The other results of this season of work were also of much archæological interest. From the same cemetery were obtained a magnificent burial of the XII dynasty, in richly-painted coffins, with a painted canopic box containing the vases of viscera all inscribed, two beautifully wrought boats, and five carved statuettes. And

Boring holes in earthenware vessels can be accomplished with the aid of a lathe, a copper rod, and a mixture of emery powder and linseed oil.

HYGIENE IN EUROPEAN SCHOOLS.

THE health of school children is becoming more and more a matter for the attention of educationalists. Writing from Brunswick, Consul T. J. Albert describes some of the plans adopted in some European cities. In Grunewald, a suburb of Berlin, this summer, for the first time in a public school, instruction free of charge in swimming has been given to the children. The Berlin municipality will establish a forest school, which will be a complete boarding school, where the pupils will reside. There are already 200 children counted upon as pupils. The subjects of children's health and school hygiene at the approaching Congress

FIG. 8.—MODERN CEMETERY AT RIFEH, SHOWING SERRATED WALLS USED 5,000 YEARS AGO.

for Hygiene and Demography will be more broadly considered than heretofore. During the present holidays increased attention has been given to juvenile sports and rambles in the country.

The Prussian Minister of Public Instruction has issued a direction worthy of imitation. In order to prevent as far as possible the injurious effects of long sitting by the pupils in the schools, he recommends that, on days when the regular instruction in gymnastic exercises is not given, such free exercises without apparatus should be taken by the male and female scholars in a systematic manner as will promote the invigoration of their health and will be specially conducive to good carriage. Before issuing a general order he desires trials to be made in a number of schools of different sorts. Such arrangements are to be chosen as the practical knowledge of the managers and teaching staff think can with care and circumspection be safely carried through. The exercises are to last five to ten minutes, which time is to be added to suitable pauses between lessons. The bodily exercises are to be in the open air or in a closed room after thorough ventilation.

In Switzerland the city of Berne has established a permanent exhibition for school hygiene. In the city of Basel the Liberal School Union has adopted a resolution demanding obligatory instruction in swimming for the upper classes of the public schools, the erection of school sanitariums, and the completion of the Institute for School Physicians. The city of St. Gall has made a trial of special classes graded according to the mental capacity of the children, similar to the Mannheim model.

THE "CONEY" OF THE BIBLE.

WHAT IT IS ZOOLOGICALLY.

BY R. LYDEKKER.

Few persons appear to be acquainted with the proper meaning of the word "coney" or "cony." Its various European names denote the rabbit, which is indigenous in the western Mediterranean countries, although some of the names also have been applied to other burrowing animals. In England the word "coney" seems, however, to have always been restricted to the rabbit, and is still used in summonses for trespass and other legal documents to denote that rodent.

When the translators of the authorized version of the Bible came to the word *shaphan* in the well-known passages in Proverbs xxx. and Psalm civ., which, from the context, evidently indicates a small quadruped dwelling among rocks and hiding in their interstices, they not unnaturally concluded that the coney was the animal referred to, being quite unaware that it is unknown in Syria and the neighboring countries. That they made a bad shot is certain, but the mistake is quite excusable, and (although the *shaphan* has no more to do with a rabbit than it has with a cat) it is difficult to see how they could have done much better, short of retaining the original Hebrew word, for at that time the creature in question was probably unknown in Europe, and certainly had no distinctive English name.

For that matter, it has practically none at the present day; and it is a matter of considerable difficulty to decide upon a satisfactory artificial title. That it is inadmissible to follow the Bible translators and to call the *shaphan* the *coney* is perfectly clear, although this has been done by a well-known American writer in the October number of the Century Magazine.

In scientific zoology the *shaphan* was for many years known as *Hyrax syriacus*, but it has latterly been discovered that it has an earlier generic title, and it is, in consequence, now generally called *Procavia syriaca*. Etymologically both these names are singularly unfortunate and misleading, *hyrax* being the Latinized form of the Greek *hurax*, signifying a shrew-mouse, while *procavia* indicates an animal nearly related to the guinea-pig; and the *shaphan* has no more kinship with either of these animals than it has with the coney. Such matters, although annoying to the etymologist, are, however, not regarded by naturalists as of much moment.

In addition to the Syrian *shaphan*, there are a number of more or less nearly allied representatives of the same group spread over Africa. To the one inhabiting Capé Colony the Dutch have given the name *klip-dass*, equivalent to rock-badger, a term which has been modified by the English colonists into *dassie*. The former name, whether in the original Dutch or translated, is quite as objectionable as rock-coney (which has been suggested as a substitute for coney, pure and simple); first for the reason that the creature has nothing in common with a badger, and secondly because some of its African relatives are tree-climbers. "Dassie" has too much the character of slang to be suitable for general adoption.

We are, therefore, driven to adopt as the English designation of these animals either the discarded scientific name *hyrax* (for *procavy* would scarcely do) or the Hebrew *shaphan*. It is a choice of evils, but of the two hyrax appears the less objectionable; although if either of these titles were introduced into our translation of the Old Testament, it is probable that ordinary readers and listeners would not be much the wiser.

To the naturalist the Syrian hyrax and its African relatives are some of the most interesting of all living quadrupeds. Unknown in the extreme north (which is, zoologically, a part of Europe), hyraxes are found throughout most of the rest of Africa, but, with the exception of the outlying Syrian species, which extends into Arabia, are unrepresented in any other portion of the globe. Till a few years ago they were supposed to have no near relations, either living or extinct, and thus to form an isolated, and, so to speak, friendless, group by themselves. Discoveries in the upper Tertiary formations of the island of Samos have, however, enabled naturalists to determine that certain problematical jaws and teeth known long previously from the corresponding rocks of Greece indicate comparatively gigantic extinct species of the group. Still more recently the wonderful discoveries of fossil quadrupeds in the lower Tertiary rocks of the Fayum district of the Libyan desert have revealed the former existence of quite a number of extinct relatives of the hyrax, most of which largely exceeded their living representatives in the matter of bodily size.

The present geographical distribution of the hyrax group is of itself sufficient to suggest the idea that these animals originated in Africa; and this supposition has been converted into a certainty by the discoveries to which allusion has just been made. It appears, indeed, that in early Tertiary times Africa was the home of a very remarkable assemblage of animals, comprising the ancestors of the modern elephants, hyraxes, and sea-cows, but with no representatives of the giraffes, antelopes, buffaloes, and hippopotamuses which are now so characteristic of that continent.

In the completely isolated Africa of those days the aforesaid animals continued to develop and flourish by themselves till the time came when a substantial connection was established with the great northern continent. The elephants immediately took advantage of the bridge to make their way northward, and thus to spread over nearly the whole of the globe, although they now survive only in India and in the old African home. The hyraxes, on the other hand, which appear always to have been, like their modern Syrian representatives, "a feeble folk," were evidently not such good travelers, and only succeeded in making their way into the countries fringing Africa, such as Greece, Samos, Syria, and Arabia, where they survive at the present only in the last two of these, in the form of the diminutive Biblical species. At no time did they effect an entrance into Madagascar, which has been isolated from the Ethiopian mainland for untold ages.

Hyraxes are included in the great order of ungulate, or hoofed, animals, of which they form a special group, or sub-order. One reason for thus associating them is the fact that the toes, of which there are four functional ones in front and three behind, are protected by broad nail-like hoofs, closely resembling those of a rhinoceros. Indeed, the whole hind-foot is remarkably similar to that of the latter animal. A second reason is that the molars, or cheek-teeth, also approximate to the rhinoceros-type, although they are more like those of certain extinct European animals allied to both rhinoceroses and tapirs.

The Syrian hyrax, as is so well indicated in the Bible, like many of its nearest relatives, dwells in companies amid rocks, and is a strict vegetarian. There are, however, a number of African species which spend their time in the trunks and larger branches of trees, the holes in which afford them comfortable sleeping places. These tree-hyraxes, as they are called, have the habit of hunching up their backs into the form of a high arch, which gives them a most peculiar appearance when at rest. As a rhinoceros-like foot is not very well adapted for holding on to smooth surfaces of rocks or the bark of trees, these animals have the power of elevating the center of the sole so as to form a sucker, and are thereby enabled to clamber or climb about with facility.

ELECTRIC WAVES IN THE SERVICE OF METEOROLOGY.

IN a memoir recently presented to the Royal Academy of Science and Arts of Barcelona, G. J. Guillén-Garcia discusses the investigation of thunderstorms and their bearing on weather forecasts.

Garcia has installed at his laboratory an observatory, in which any atmospheric discharges occurring either near or at considerable distance are observed by means of graphical apparatus (keraunographs) and acoustic apparatus (keraunophones). Especially by the use of the latter he has succeeded in obtaining results of considerable value to the study of meteorology, the more so as by combining the records of this apparatus with barometer, anemoscope and anemometer readings, reliable weather forecasts can be obtained.

The graphic apparatus, which are practically identical with ordinary wireless telegraph receiving apparatus, show the advantage over the acoustical apparatus, that they give information as to the beginning of a remote thunderstorm or single flashes of lightning. On the other hand, these apparatus cannot record several thunderstorms simultaneously, which is quite feasible in the case of keraunophones, which, owing to acoustic differences of the signals corresponding to each thunderstorm, will allow the various simultaneous discharges to be distinguished. Keraunographs are capable of giving records of thunderstorms located at upward of 600 miles distance and of ascertaining whether the thunderstorm is approaching or departing.

The best results are secured from a combination of the graphic and acoustic apparatus, as suggested by Garcia, the acoustic apparatus being used whenever a record appears on the keraunograph. This method is obviously preferable to the use of telegraphs, giving as it does automatic information of atmospheric discharges occurring within a radius of at least 600 miles, whereas telegraphs give records only at certain points and at certain times of the day.

This method may prove specially valuable in Western Europe; that is, Spain, France, and Great Britain, which countries are rather badly off in regard to weather forecasts. In fact, all depressions occurring in Western Europe will come from the Atlantic Ocean, that is, from a region the atmospheric conditions of which can never be properly investigated. Now the keraunophone, in conjunction with a convenient antenna for receiving electric waves, might be able to replace the wanting meteorological observatories of the Atlantic Ocean.

In connection with his thunderstorm observations, Garcia distinguishes five degrees of intensity in the acoustic records given by the apparatus, viz., "very feeble," "feeble," "medium," "strong," and "very strong."

The "very strong" signals will correspond to easily visible flashes of lightning, when the thunder, however, is not heard. These occur at a distance of at least 6 miles. The "strong" signals correspond to atmospheric discharges, the flashes of which are visible only by night through reflection, this visibility extending generally to 60 miles. "Feeble" noises at the Barcelona observatory correspond to thunderstorms occurring in the summer in central Spain—a distance of several hundred miles—and which are frequently determined by an atmospheric center of depression located there. "Medium" signals, intermediary between "strong" and "feeble," correspond to thunderstorms occurring in the neighborhood of Barcelona. "Very feeble" signals correspond to very remote atmospheric discharges.

Between these five degrees there is such a marked difference that local differences in the intensity of the various discharges of a given thunderstorm are practically without any influence.

To ascertain the laws, according to which atmospheric discharges vary as they recede from the observatory, and to record intensity districts on a map, careful records should be collected for several years. Garcia has for several months taken accurate records of thunderstorms which have occurred in upward of 130 localities and has thus ascertained the *isokerauno-phonic* areas for Spain and the neighboring countries. Far from being concentrical, these surfaces show the most singular forms, electric waves being propagated on land and sea with different intensity, while being influenced by any intermediary mountains. In fact, certain mountain chains constitute a sharp boundary between atmospheric discharges audible with a given intensity.

As regards the practical use of these thunderstorm records for meteorological purposes, the following may be stated:

Whenever no noise is heard in the keraunophone, this is convincing proof of the absence of any atmospherical discharge within a given radius of 600 miles or more from Barcelona. An observer can thus ascertain that from the Atlantic Ocean to Italy and from Northern France to Northern Africa there are no thunderstorms.

If the keraunophone at the various times of observation gives signals of equal intensity, this is an indication of the actual thunderstorm being confined to one acoustic district, and not approaching the observatory.

If the keraunophone gives very feeble noises, there is a distant thunderstorm, which will hardly reach the point of observation, or at any rate not for many hours. As regards the probable time taken by an approaching thunderstorm to reach the observatory, some hint may be derived from the fact that centers of atmospheric depression on the Atlantic Ocean generally travel at a speed of 17½ miles per hour and within Europe at a speed of about 17 miles.

If several noises of different intensity are heard simultaneously in the keraunophone, this is an indication of several atmospheric discharges occurring in different districts.

The apparatus further allows some conclusions to be derived as to the intensity of a thunderstorm; whenever sharp noises are heard from time to time, the thunderstorm consists of a limited number of electric discharges. If noises are very frequent, the thunderstorm is very intense.

If the barometer is either rising or permanently fixed at a point upward of the limiting isobaric line, the thunderstorm signaled by the keraunophone is not likely to arrive on the same day, the observatory being either outside of its range or representing a center of high atmospheric pressure.

If the noises heard with each observation are increasing in strength, this is an indication of the thunderstorm approaching without being bound to reach the observatory. A gradual decrease in the intensity of the noise obviously shows that the thunderstorm is withdrawing.

If the thunderstorm be located within a center of depression controlling the observatory, the district in which it is located can be readily ascertained. The rotary antenna suggested by Marconi, by the aid of which the direction of origin of electric waves is recognized, will prove specially useful in this connection.

As the apparatus used by Garcia will allow not only the atmospheric discharges, but also the winds determined by the latter to be observed in the neighboring districts and countries, these observations are likely to afford valuable information, not only for agriculture, but also for coast shipping.

THE CLIMATE OF MARS.

ITS EFFECT ON THE HABITABILITY OF THE PLANET.

BY ARTHUR STENTZEL.

ORGANIC life is possible only within a narrow range of temperature, of which the lower limit is the freezing point of water, 0 deg. C. (32 deg. F.), and the upper limit is the temperature at which albumen coagulates, 42 deg. C. (107.6 deg. F.). Living organisms may withstand repeated brief exposures to temperatures beyond these limits but they are killed by continuous exposure to such temperatures. The possibility of life upon Mars depends, therefore, first upon the surface temperatures of that planet.

From the relative distances of Mars and the earth from the sun it can be computed that the intensities of solar radiation on the two planets are as 431 to 1,000. Now it appears from the researches of Langley, Hann, and others that an area of 1 square centimeter, placed normally to the sun's rays at the upper limit of the earth's atmosphere, would receive in 1 minute 3 gramme-calories, or a quantity of heat that would raise the temperature of 1 cubic centimeter of water from 0 to 3 deg. C. This area of 1 square centimeter would receive 1,375.2 such calories in a day, and 501,948 calories in a year. The total amount of solar radiation annually received by the earth is obtained by multiplying the last number by the number of square centimeters contained in a great circle of the earth. The result is $20{,}116 \times 10^{20}$ gramme-calories. Hann has calculated that the annual solar radiation, if not diminished by atmospheric absorption, would suffice to evaporate a layer of water 818.6 centimeters (27 feet) deep, or to melt a layer of ice 6,567 centimeters (215 feet) thick, at the equator, or to melt a layer of ice 5,377 centimeters (176 feet) thick over the entire globe.

For Mars, it is only necessary to multiply all these results by 0.431, or about 2/5.

On both planets, however, a large part of the solar radiation is absorbed by the atmosphere, and another portion is reflected into space. The loss by absorption in the Martian atmosphere could be computed very easily if that atmosphere were similar to the earth's atmosphere, but in reality it is very different. Although we know little about the atmosphere of Mars it is certainly less dense than the atmosphere of the earth, because the force of gravity on Mars is less than 2/5 (0.38) as great as terrestrial gravity. The evident scarcity of water on Mars and the clearness with which the details of Martian topography can be observed indicate, furthermore, that the atmosphere of the planet is almost cloudless.

The climate of a planet is determined chiefly by its internal heat, solar radiation, and atmospheric absorption. In the case of Mars we know with any degree of certainty only the second of these three factors, the solar radiation, which has already been discussed. In regard to the other factors we can only make more or less probable conjectures.

The value of the albedo of Mars (0.29 according to Mueller) shows that the planet is not at all self-luminous, and the entire absence of volcanic activity indicates great thickness of its lithosphere or solid crust. According to the cosmogony of Kant and Laplace, Mars is really older than the earth, but on the writer's theory of the origin of planets from scattered nebulæ collected by the sun from without, Mars is really younger than the earth. The example of the moon which, though as old as the earth, has long been cold and dead suggests that Mars is also a prematurely aged planet. Observation and theory agree in indicating that the flow of heat from the interior through the crust to the surface is less in Mars than in the earth. The terrestrial flow is only about 54 gramme-calories per square centimeter per year which, according to Trabert, would raise the mean temperature of the earth's surface only 0.1 deg. C. (0.18 deg. F.). Hence, for Mars as for the earth, internal heat may be disregarded as a climatic factor.

An estimate of atmospheric absorption on Mars may be obtained from a comparison of Martian and terrestrial conditions. According tc Angot and others, the coefficient of diathermancy of the earth's atmosphere, when clear, is 0.6. From this it follows that only 44 per cent of the solar radiation which falls on the atmospheric envelope reaches the surface of the earth. The percentage becomes 55 if the value 0.7 is assumed for the coefficient of diathermancy. In other words, about half the solar radiation is absorbed by the atmosphere. Another large portion, averaging about 25 per cent, is lost by reflection from clouds. Hence only 25 per cent of the radiation reaches the surface of the earth.

For the thin and permeable atmosphere of Mars the coefficient of diathermancy must be at least 0.7, and it is probably as high as 0.8, and the effect of clouds is negligible. Hence the surface receives about 60 per cent of the radiation, 2.4 times the proportion received by the earth's surface.

This factor, 2.4, more than counterbalances the factor 0.431, which results from the greater distance of Mars from the sun, and the product $2.4 \times 0.431 = 1.0344$, represents the intensity of solar radiation on the surface of Mars, which is therefore nearly 3½ per cent greater than the radiation received by the earth's surface.

On the earth the radiation actually received by the surface produces a mean annual temperature of 26 deg. C. (78.8 deg. F.) at the equator, and 26.4 deg. C. (79.5 deg. F.) at the hottest zone, or "thermal equator," at 10 deg. north latitude. The corresponding temperature reckoned from the absolute zero (—273 deg. C.) is 299 deg. C. This is produced by a daily radiation of $1375.2 \times 0.25 = 343.8$ calories. Hence, as the daily radiation at the Martian equator is $592.7 \times 0.60 = 355.6$ calories, the resultant mean temperature is 309 deg. C. absolute, or 36.7 deg. C. (98.1 deg. F.) on the ordinary scale. Hence the mean annual temperature at the Martian equator exceeds that at the earth's equator by about 10 deg. C. (50 deg. F.).

Similar differences must prevail at other latitudes. At the earth's poles the solar radiation has about 1/5 its value at the equator, and the mean annual temperature is —20 deg. C. (—4 deg. F.). At the Martian poles the mean annual temperature must be about —11 deg. C. (+12 deg. F.). The mean annual temperature of the entire earth is 14.4 deg. C. (57.9 deg. F.) and that of Mars 23.8 deg. C. (74.8 deg. F.).

The difference between the temperatures of day and night must be very great on Mars because of the rarity and clearness of the atmosphere.

The foregoing considerations show that the polar caps of Mars may very well consist, not of carbonic acid, as has been assumed, but of ice and snow, accumulated in a winter twice as long as ours and gradually melting away in summer, as they are observed to do. Though water is not abundant on Mars, its presence there has been demonstrated by the spectroscope. Yet the greater part of the surface is evidently a desert, as indicated by its red color, and the tropical and "temperate" zones must be very hot. On the whole, therefore, the climate of Mars is not unfavorable to the development of a flora and fauna of some sort, and the possibility of organic life suggests that the network of straight canals may really be an irrigation system constructed by a highly civilized population.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Prometheus.

A NEW METHOD OF COLOR PHOTOGRAPHY.

THE latest method of color photography known as the "Warner-Powrie" process has just been published in England. It will presumably be some little time before the plates are generally obtainable, but so far as can be judged from the examples shown and the details of their preparation, it is a process that will offer special advantages. Mr. Powrie has been working at the subject for many years, and has succeeded in producing a triple-colored lined screen with better and finer lines than has been possible by previous methods, and without either gap or overlap. He discards ruling in favor of a very ingenious method of printing that does away with all need for the troublesome registration that becomes almost impossible with fine lines. The glass is coated with a bichromated colloid, exposed under a black-lined screen that has spaces half the width of the lines, and developed in warm water. This leaves the colloid in lines with spaces of bare glass twice as wide as the lines. By immersion in a solution of a green dye the lines are stained, and by the application of formalin or chrome alum the colloid is made quite insoluble and the dye fixed. The plate is coated again, exposed under the same black-lined screen, the only precaution being that the green lines already made shall be covered with the black lines of the overlying screen. After exposure and development the plate is immersed in a solution of a red dye to stain the second set of lines, and again treated with a hardening agent. The plate is coated once more, and this time exposed alone with its back to the light, so that the red and green lines already made, serve to protect the coating from light action. So after development all the remaining spaces are exactly filled with colloid, and this is then dyed blue. The prepared plate is coated with a suitable photographic emulsion, and can be used in a similar way to the "autochrome" plates of Messrs. Lumière, which we have already described. The chief difference between the two apparent by mere inspection is that the colors are in lines instead of as a random grain. But the lines can be made so fine that they are invisible to a normal eye without assistance.

It is obvious that the "autochrome" and the "Warner-Powrie" plates, and any plates in which the surface is apportioned to three colors for color reproduction, must absorb about two-thirds of the light that would pass through them if the colors were not there. A simple color, such as red, is produced by a silver deposit that covers the green and blue colors that are in the area that is required to be red, and this area is therefore one-third red and two-thirds black. A print on a "bleaching-out" paper would give its colors mixed with a double area of black, and therefore be uselessly dark. It is difficult, if possible, to obviate this with a random distribution of the colors, but Mr. Powrie, with his plates, overcomes the difficulty by separating the plate and the paper with a thin sheet of celluloid or glass, and by two mirrors on opposite sides of the printing frame gets oblique light in two directions, as well as direct light at right angles to the surface, and so causes each colored line in the plate to give a line on the printing paper three times its width. In this way, each color—red, green, and blue—produces its effect over the whole surface of the paper, the color patches are continuous (free from black), and what should be white parts are completely bleached instead of being colored like the original. In the same way, but using ordinary plates, and red, green, and blue light separately for the exposures, a separate negative can be obtained of each of the three colors, with a continuous image on each, and these can be used for any method of three-color printing. A single exposure on a single plate will thus give all that is necessary for the preparation of the three-color records which hitherto have been obtained by separate and generally consecutive exposures on the original.—Nature.

NORWEGIAN SARDINE PACKING.

CONSUL F. S. S. JOHNSON, of Bergen, furnishes the following information as to the sardine industry at that Norwegian port:

The fish are caught by nets in the fjords north of Bergen, though at times they are had in the inlets between Bergen and Stavanger. They resemble small herring, and are from three to four inches in length. On their arrival at the canning factory the fish are placed in tubs and washed, after which they are put in salt for a quarter of an hour and then sent to the storing room, where the different sizes are classified. From this department they go to the room where they are prepared for smoking. An iron rod (which holds twenty or more fish) is passed through the fishes' eyes, fifteen or twenty iron rods making a frame. As soon as a frame is finished it is placed in a slide of a brick oven over a wood fire and allowed to remain there for twenty minutes. It is then removed and sent to the clipping department, where the heads are cut off by means of scissors.

The fish then go to the packing department, where they are packed in cans. The cans are first prepared by being half filled with olive oil. The fish are then laid in lengthways in the cans, which hold from twelve to thirty fish, according to size. A rubber band is placed on the edge of the top of the sardine box before the lid is closed by means of a machine. In the last stage the boxes are placed in a caldron of hot water and cooked or steamed for twenty minutes, then taken out and examined to see if there are any leaks or defects and sent to the packing and labeling rooms.

Bleaching of Fine Pearls.—To bleach fine pearls it is often sufficient to allow them to remain for some time in concentrated javelle water, then to rinse them several times in clear water. Oxygenated water (hydrogen bioxide) may also be used. Mounted pearls may be immersed in javelle water; the metal itself will be cleaned at the same time. Care should be taken to wash the articles with soap and water, then with clear water, and dry in sawdust.

ELECTRICAL NOTES.

An extensive wireless telegraph system has been erected by the United Fruit Company on its fruit steamers, and at numerous points on the Gulf of Mexico and the Caribbean Sea, for communication between the offices, steamers in transit, and its plantations in Central America and the West Indies. A station was recently added at San Antonio, at the extreme western end of Cuba.

Wireless communication was picked up with a steamer at Panama in the Pacific by the Savannah Line steamship "City of Savannah" while off the South Carolina coast. The distance was so great that only a few words of the message were read. In spite of the last-mentioned fact, the mere establishment of communication over such a distance shows remarkable possibilities of wireless telegraphy under favorable conditions, since the other steamship was equipped with instruments no doubt designed to give efficient service over but a few hundred miles.

The Westinghouse Company is constructing a single-phase 11,000-volt, 15-~ locomotive for the Pennsylvania Railroad, to be capable of exerting a maximum of 4,000 horse-power. The locomotive is to consist of two separate halves; one of these has already been constructed, and has been subjected to some trials. On the test track at Pittsburg, which is 5 miles long and consists of a succession of curves, a speed of 73 m.p.h. was attained; it is claimed that a speed of 90 m.p.h. can easily be reached on a straight track. The maximum draw-bar pull exerted by this half locomotive was found to be 24,000 pounds. The complete locomotive is to be equipped with four 500-horse-power motors (capable of standing an overload of 100 per cent), each weighing 20,000 pounds. The normal voltage per commutator is 300, and the power-factor at full-load is 93 per cent. The motors are of the gearless type.

Injury to a single insulator sometimes renders the whole transmission line entirely inoperative until the faulty insulator is discovered and replaced, says Mr. L. C. Nicholson in the Proceedings of the American Institute of Electrical Engineers. Even when long lines are sectionalized by disconnecting switches spaced at regular intervals it is a tedious process to test section after section and then to locate the exact point of failure by patrolling the section. The ordinary loop tests can sometimes be employed. If, however, the fault be a partial one, as, for instance, when an insulator becomes defective by puncture, these tests cannot be employed, as a high voltage is necessary to produce any current flow. The author describes a test suitable for everyday working. The particular plant on which it has been applied transmits three-phase power at 60,000 volts with a frequency of 25 over a line 160 miles long. The line conductors are of aluminium, spaced 7 feet apart, and are carried partly on steel towers and partly on wooden structures. The step-up transformers operate mesh-star with neutral grounded. Hence when an insulator breaks down, the arc between the line and the insulator pin is maintained and further service cannot be resumed until the insulator is replaced. To locate a fault, a loop is formed by connecting the faulty line in parallel with one of the others. A high-tension voltage is applied to this loop at the generating end, and the currents in the main and the two branches of the loop are noted. The ammeter readings, together with the known electrical constants of the line, serve to locate the fault. It is necessary to put a resistance in series with the loop. Ordinary cement concrete columns supplied with expanded metal terminals make a cheap and very satisfactory form of resistance for high-tension circuits. Four columns, 12 feet long, 1 square foot in section, each having a resistance when cold of about 2,000 ohms have been used singly or parallel. The temperature resistance coefficient of concrete being large and negative, it is an easy matter to arrive at a proper resistance by heating the columns, by letting the current pass through them. It has been found that as a rule a 1,000-ohm concrete resistance on the high-tension side does not prevent flashing of a broken insulator, and it permits of satisfactory current readings. Occasionally a comparatively low resistance must be used to maintain the arc. The longer the striking distance and the less complete the fault the larger the current required. The effect of the arc upon the cable is an important consideration. If it is burned so as to require splicing, considerably more time is consumed in restoring the line to service than if only a broken insulator has to be replaced. Damage to the cable by an arc carrying 100 amperes for 40 seconds has been found to be trifling when the striking distance is several inches. A record is given of the faults located by the two-ammeter method, and in no case is the error greater than a fifth of a mile—generally only a few hundred feet. The time taken by the test is only about 30 minutes. If there was a fault on the two lines making the loop the test would give an erroneous result. This case, however, has not yet arisen, and is very exceptional.

ENGINEERING NOTES.

The lime produced in the United States in 1906, says the United States Geological Survey, amounted to 3,197,754 tons, valued at $12,480,653, an increase over the production for 1905 (which amounted to 2,948,100 tons, valued at $10,941,680) of 213,654 tons in quantity and of $1,130,425 in value. The average price per ton in 1906 was $3.90, against $3.67 in 1905, an increase of 23 cents.

Orders have just been received at Portsmouth which seem to substantiate the reports of the intended great developments in the matter of oil fuel for ships of the British navy. Storage tanks, to contain at least 20,000 tons of oil, are to be constructed on the Gosport side of the harbor. Warships of all classes are to go alongside these tanks for supplies, and in order to make this possible a large pier is to be constructed. Extensive dredging operations will be carried out to make the approach to the pier sufficiently navigable.

According to the Manila American (Manila, P. I.), a circular has been issued by the Board of Foreign Affairs at Harbin to the effect that no foreigners shall henceforth be allowed to engage in mining enterprise within 30 li—or, say, within a distance of 11¾ English miles—of the railway, without a special license. Mines which are already being worked will be examined to ascertain their daily output, and as soon as the proper agreements have been drawn up with the foreign countries interested, a scale of taxation will be arranged for all mining enterprises.

An exhaustive monograph on the asbestos and manganese ore deposits of Ilocos Norte, by Mr. Warren D. Smith, is published in the Philippine Journal of Science (vol. xi., No. 3). The deposits occur in the northern portion of the island of Luzon, and are of considerable extent. The region is of special interest from the varied character of the geology. More diverse features are exhibited than in most parts of the archipelago. The region is primarily one of metamorphism, and this metamorphism is regional rather than local.

The Intercolonial Railway of Canada is installing a service of steam motor cars. In general appearance the cars resemble combination passenger and baggage cars often seen in this country but the space usually reserved for baggage is occupied by a locomotive boiler and coal bunkers. The locomotive is four-wheeled, and its wheels take the place of the regular passenger car truck at one end of the car. The car is 66 feet long over the end sills and has a seating capacity of 52 persons. The locomotive is rated at about 200 horse-power and is designed to give a speed of 25 miles per hour on a 1 per cent grade. The cars will run either end first.

C. Bach, writing in the Zeitschr. Vereines Deutsch. Ing., gives detailed results of a number of bending and direct tensile tests of plain and reinforced concretes, from which it is concluded that the concrete *per se* is capable of the same amount of extension in either case. The amount of extension before rupture of plain specimens, and before the opening of hair-cracks in reinforced beams, varies from 0.065 to 0.367 millimeter per m. according to mixture and preparation. Concrete which sets under water expands, and concrete setting in the air contracts. Thus in reinforced concrete initial stresses in the reinforcement and concrete are produced, which in the case of water setting are tension in the metal and compression in the concrete; for air setting the signs are reversed. The influence of these stresses upon the extensibility is well marked: e. g., water-set samples showed 0.205 millimeter per m. extension, as compared with 0.097 millimeter per m. for the same mixture set in the air, and having similar reinforcement.

A bulletin of the engineering experiment station of the University of Illinois gives results of tests of plain and reinforced concrete T-beams and columns of several designs. Beams of flange width of 2, 3, or 4 times the width of web, and having reinforcement equal in area to 1 per cent of the inclosing rectangle, had the characteristics of rectangular beams, and the critical failure was due to overstrain of the steel, even with steel of 54,000 pounds per square inch yield-point. Wide flanges gave but little added strength at points of maximum bending moment, but gave increased stiffness. The vertical stirrups used proved effective web reinforcement. Diagonal tension cracks appeared at or above loads at which failure by diagonal tension may be expected in beams without web reinforcement. In the case of columns, assuming that the stress in the steel is proportional to the deformation of the column, i. e., that there is ample adhesion, the average maximum stress in the concrete is found to be 15 per cent less in the reinforced than in plain columns (1,290 and 1,550 pounds per square inch respectively). The modulus of elasticity at low loads was 2,250,000 pounds per square inch; this is increased by age and decreased by repetition of loading. The ratio of stress taken by steel to stress borne by concrete varied from 12 to 34. The concrete mixtures were 1:2:4 and 1:2:3½, and the age 60 to 105 days.

TRADE NOTES AND FORMULÆ.

Ebonite.—Melt and mix 100 parts of India rubber, 45 parts of sulphur, 10 parts of gutta percha. Run in a suitable mold, that is not affected by sulphur, and expose for 2 hours, to a temperature of 600 deg. F.

To Bronze Iron Wire (according to Otte).—The iron is galvanized by laying it in very dilute hydrochloric acid, in which it is in contact with zinc, then dip it in a solution of 4 parts of blue vitriol and 3 parts of tin chloride and pass it finally through the drawing iron.

Holding Cement for Microscopic Preparations.—2 parts of wax are melted in a porcelain saucer and to this 7 to 9 parts of ordinary rosin added, thoroughly stirred and filtered through gauze. To use, dip a hot wire into the cement and pass it along the edges of the covering glass.—Bersch.

Matt Albumenized Paper.—Strong paper (such as rough drawing paper) is steeped for a few minutes in a solution of alum 7 parts, gum 2 parts, water 200 parts, allowed to drain, pressed between blotting paper and placed damp in a bath of albumen 10 parts, ammonia 2 parts, in which it is allowed to float for 15 to 20 seconds, then dried.—Bersch.

To Determine the Age of Eggs.—Dissolve 5 ounces of salt in 1 quart of water and place the egg in the solution. If it is a day old, it will sink to the bottom, if older it will not reach the bottom, if 3 days old it will float below the surface of the water; if more than 5 days old it will come to the surface and float higher, the older it is.—Bersch.

To platinize iron (according to Dodé) first heat and give it a coat of 22 parts of borate of lead and 4.5 parts of blue vitriol mixed with turpentine to a paste, washing it off after a while. Platinizing formula: 10 parts of platinum, changed into platinic chloride, mixed with 5 parts of ether and exposed to the air until the ether is evaporated. The residue is mixed with 20 parts of borate of lead, 11 parts of red lead and some oil of lavender to a paste, which is mixed with 50 parts of amyl alcohol. Dip the object in the mixture, dry and heat it.

Artificial Ebony.—One part of Campeachy wood is boiled out in 10 parts of water, strained through linen and then boiled down to one-half. To every quart of fluid thus produced, add 10 to 15 drops of neutral, thoroughly saturated indigo solution. The surfaces to be colored are first treated with a hot, saturated solution of alum, then painted several times with the indigo decoction, then well rubbed with a hot, concentrated solution of verdigris (basic copper acetate) in acetic acid, until the desired black color is obtained. —Bersch.

Electric Machines.—Amalgams for the frictional parts of electric machines are combinations of quicksilver, tin, and zinc. The quicksilver is heated to 302 to 392 F., transferred to a wooden box, the melted tin and zinc added to it, the box closed by a lid and mixed by vigorous shaking. The proportions of the mixture (according to Singer) are (a) 6 parts of quicksilver, 2 parts tin, 1 part zinc; (b) 7 parts quicksilver, 4 parts zinc, 2 parts tin; various other proportions of these ingredients are sometimes used.—Bersch.

Cement for Precious Stones.—(1) Fish glue, softened in water, is dissolved in the least possible quantity of alcohol at a low heat. In each 60 parts by weight of this mass, dissolve 0.5 part of gum ammoniac, add a solution of 2 parts of mastic in 12 parts of strong alcohol, and place the cement in close stoppered bottles for preservation. Before use, it must be softened in a water bath; (2) 1 part of isinglass and 2 parts of white glue, dissolved in 30 parts water by heat and evaporate to 1/6 of its bulk. Add 1/30 of a part of mastic, dissolved in half a part of alcohol, then, stirring constantly, add 1 part of zinc white; (3) equal parts of a solution of isinglass in water and a solution of mastic in alcohol, are intimately mixed. This must always be used fresh.

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